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ARCHÆOLOGY.

Age of "Prehistoric" Remains Found at Kansas City, and of the Races of Men Associated with Them.

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[Read before the Kansas City Academy of Science, September, 1876.*]

MR. PRESIDENT, LADIES AND GENTLEMEN:—I have the pleasure of presenting before you this evening several fragments of the handiwork of our "old settlers," which will possess great interest, no doubt, to those who are fond of contemplating relics of the past. Unlike the annual reunions of our modern "old settlers," the reunions of the "prehistoric old settlers," of whom I have the pleasure to speak this evening, long since have been buried in the mysterious vistas of the past, or have been transferred from scenes of earth to those of their happy hunting grounds in the poetic realms of the Great Spirit.

I invite your attention first to a fragment of chert, which I had the good fortune to find the latter part of the past spring, imbedded in the Loess or Bluff formation. It was found at a depth of about three feet beneath

* This paper should have preceded the one read by Judge West before the Academy of Science, which was published in the first number of this Magazine.

the present surface, near the intersection of Missouri avenue and Troost avenue in Kansas City, and about twelve hundred feet from the ancient shore line of a former lake, of which I shall hereafter have occasion to speak. Its position was such as to leave no doubt that it must have been deposited where I found it at the time the Bluff formation was yet going on, and probably about its close in this locality.

As chert, this fragment has a long and interesting history to those who can trace its various transmutations down through innumerable ages in the past. But, what will claim our attention this evening is its connection with the history of man. You will perceive that it has been fashioned by the hand of man into a spear head, or arrow head, for use in war and the chase, and affords unmistakable evidence of former association with him, evidence which it has faithfully preserved through vast ages and now presents to us, with all the truthfulness in detail as when it first received man's impress upon it. It stands before us now, a mute, unerring witness of man's great antiquity.

To approximate the time of its association with our race, which gives to it its great interest, we must consider the age of the formation in which it was found imbedded. Some of you, no doubt, will remember that excavations were made in the bed of the Missouri river for the purpose of obtaining a solid foundation for the piers of the railroad bridge erected across it at this place. Solid rock was not reached at the fifth pier from the left bank until the excavation had attained a depth of sixty-eight feet below the present river bed. From the fifth pier north solid rock was not reached at a greater depth than that here indicated, and the piers rest upon piles driven into the drift. From the fifth pier southward there is a gradual upward slope of the rocks to the southern shore line, where they are exposed above the surface in the south bank of the river. This rock formed the old bed of the river, which, sloping downward toward the north bank, is at an unknown depth lower than the present bed.

At this time it is probable that the Kansas river had its outlet into the Missouri at or near the present mouth of the Big Blue river; its channel then passing along the McGee creek valley, in the south part of the city, by way of Judge Carey's, thence along Goose Neck creek valley to the present channel of the Big Blue, not far above where it empties in to the Missouri.

I was informed by Gov. W. P. Hall, of St. Joseph, several years ago, that in the excavations made for the piers of the railroad bridge across the Missouri at that place, large boulders, worn pebbles, sand, and other drift material were encountered, forming the entire matter excavated down to the solid rock which marks the old bed of the river at that place. The same is true of the excavations made here; boulders, worn pebbles, sand, and drift material were found in the excavations made, reaching down entirely to the rock forming the old river bed. Our present river channel, at this place, occupies a position over the south edge, or slope, of the old and now buried

channel. When this portion of our continent was at a greater elevation than at present, and our river channels much deeper than now, which is manifest from the great thickness of the drift material that overlies the undisturbed rocks which form the bottom of the old channels and marks their course, the long glacier period began. Glaciers were formed which extended from the North Pole to about the thirty-eighth degree of north latitude, having a thickness of thousands of feet, and overtopping nearly all of our mountains. During this period this irresistible mass, moving down from the north, filled the old channels of our streams and diverted some of them, as the Kansas river, which I have just alluded to. It is at the close of this long period that the computation of time associating man with this mute witness, this unmistakable work of his hand, properly begins.

At the close of the glacial period, this portion of our continent, which, during that time, had suffered great depression and was submerged, again emerged from the water and marked the beginning of our present river channels. But the emergence was not so complete but that there were left numerous lakes of various magnitudes, extending over a vast area of country, including the drainage of the Platte, the Missouri, the Mississippi, the Ohio, the Hudson, the Niagara, the St. Lawrence, and other streams east of the Rocky Mountains, as well, perhaps, as those west of these mountains. It was in these residuary lakes that the Loess, or Bluff deposit took place, precipitated from the sediment borne into the lakes by the streams affording their supply. But what is more particularly associated with my subject for this evening is the Loess formation of the Missouri, and especially at Kansas City. We have here at least three periods, or more properly, levels of Bluff deposits, one overtopping all, or nearly all, of our rocky bluffs, the other two at lower levels, corresponding with the terraces in the bluffs overlooking West Kansas. At the highest level the river, or, rather more properly, the lake into which it flowed, was probably thirty miles or more in width, embracing a large portion of its present drainage. Vast as must have been the volume of water, irresistible as must have been the floods coursing down the Missouri's water-way, produced by a much greater annual rain fall than we have at present, and the melting away of the annual snows reinforced by the melting of the retiring ancient glaciers, we are still not justified in believing that a river so vast in volume, so expanded in breadth as thirty miles or more from shore to shore, with a depth of several hundred feet, a velocity exceeding that of the present Missouri at its flood, could have been maintained. Nor is such a stream consistent with the facts presented by the bluff formation along its banks. Hence, we are led to the very reasonable conclusion, that the large bodies of water, which evidently prevailed, were lakes formed within the drainage of the river, along the general course of its channel, caused by obstructions across its way. The obstructions, no doubt, were caused by the filling up of the old channel of the Missouri, by which, in places, it was entirely diverted and the channel thrown across narrow, rocky barriers, as in the case of the Niagara. The

obstructions could not have been caused by ice of the glacier period, for the Bluff deposit was subsequent to the glacier time in this latitude, and, besides, we find imbedded in the Loess numerous shells of the Helix asbora, H. concava, H. minata, and other land and fluviatile shells. These mollusks could not have endured the cold of the glacier time, nor could they have been transplanted from a warmer latitude. These obstructions being subsequently removed by erosion, drained the lakes formed by them, and left our Bluff formation as we now find it.

The shore line of the lowest level, or that corresponding to the second or lower terrace, in the West Kansas bluff, may be traced by the line of rocky precipice partially exposed, extending from the junction of Sixth street with Bluff street, thence running by the way of the Coates Opera House, thence deflecting northeasterly to the junction of Seventh and Main streets, thence along Seventh street to Troost avenue, deflecting again northeasterly, cutting Independence Avenue at its junction with Forest Avenue, and then along the bluffs west of Dykington Park, to the river bottom. The superincumbent strata had been entirely removed down to the Bethany Falls limestone, in this entire area and extending to the river, and embracing part of Wyandotte City, before the loess deposit began. The lake had now receded to within the denuded area here defined, and extended to the bluff and some way up Line Creek north of the river, and up Turkey Creek valley to the vicinity of Rosedale, south. This is the last level of the loess, which in this last mentioned area, is from eighty to one hundred feet in thickness.

Further evidence of the gradual retiring of the lake waters with intervals of more or less accelerated or retarded recession, and that the old channel of the Kansas river had its outlet along the line I have indicated, is to be found in an old channel which was formed about the time of the last level of the lake extending from the old channel of the Kansas river, in the south part of the city, to what was then the current of the Missouri river about the margin of the bluffs on the south side. This old channel may be traced along the general course of Main street to about Fifth street, where, bending northeastwardly, it was divided into two channels, one encountering the current of the Missouri about the foot of Grand avenue, and the other about the terminus of Charlotte street, at the brink of the bluffs. The evidence of the former existence of this channel is very conclusive and is to be found in the great quantity of land and fluviatile shells which lie imbedded in the loess where the water discharged through the old channel, encountered the current of the Missouri and was arrested by it, forming eddies into which the shells drifted and were covered by successive layers of sediment. Shells are not found here in the Loess except where their motion in drifting with the current has been arrested by opposing currents, so that they are encountered only at the two places where the current of the channel encountered the Missouri's current at the brink of the bluffs about the river terminus of Charlotte street and Grand avenue.

It was in this last level of Bluff deposit, and upon the east slope of the

the Charlotte street outlet of the channel, that I found the spear head I have shown you this evening, lost, no doubt, by

"A brave old fisherman,
All of the olden time,"

while providing for his daily wants from the fishes sporting in the channel.

The Loess formation, though comparatively very new, belonging to our own geological time, estimated by years as we compute time, is indeed very old. It had its beginning about the time the Niagara river commenced its erosion of the rocky barrier which causes that world's wonder, the Falls of the Niagara. Since that time the Niagara has cut a channel through the solid rock back for a distance of seven miles. The length of time required to accomplish this has been variously estimated by Dana, Lyell and other geologists, at from thirty-one thousand to one million years.

Prof. Aughey has estimated the time required for the deposit of two hundred feet in thickness of Loess at twenty thousand years. Reckoning our Loess deposit at one hundred feet, this spear head, from these estimates, must have lain where I found it for at least twenty-one thousand years, proving man's presence at Kansas City and upon this continent for at least that great length of time.

From the evidence of the specimen I have shown you, and from a stone axe described to me by Col. Van Horn, found in grading Commercial street, near the foot of Grand avenue, buried in the Loess fifteen feet beneath the surface, and from other stone implements described by Prof. Aughey, found imbedded in the Loess of Nebraska and Iowa, I think that but little doubt can remain that man existed upon the earth at the time this deposit took place.

Did he have an existence here prior to that time? There are many reasons rendering it probable that he had. Overlying the erie clay and underlying the recent drift deposit, and the Bluff formation in Ohio, Illinois, Iowa, Missouri, Kansas and other States, is an ancient "forest bed," with a soil from six inches to three feet in thickness. This ancient forest sprang up and had a vigorous existence in a climate not materially different from our present climate. The flora was not widely different from ours, and with a river drainage almost, if not entirely equal to our present drainage, there is no apparent reason why man should not have existed at the time. There was everything needful to supply his wants, and the condition in every way was such as to render his existence highly probable, or there was nothing at least to preclude the idea of his existence. Besides, the late Dr. Koch, in a paper submitted to the Academy of Science of St. Louis, claims to have found in Benton county, in this State, two arrow heads associated with the skeleton of the Missourium in a layer of vegetable mould, covered to the depth of twenty feet with alternate layers of sand, clay and gravel. One of the arrow heads lay underneath the thigh bone of the skeleton, the bone actually resting in contact upon it, so that it could not have been placed there after the deposit of the bone. The value of the claim of Dr.

Koch has been subsequently strengthened by the discoveries of Prof. Worthen in Illinois and by discoveries in California. This vegetable mould, no doubt, formed a part of the soil of the old forest bed. Did man then exist? The evidence seems to indicate that he did. If so, we must carry him back of the recent Drift and the Bluff formation to beyond the glacier period, and associate him with the mammoth and the mastodon.

I must not leave a gap so wide as that between man at the beginning of the Loess time and the first dawn of modern civilization at Kansas City, introduced by our Louis', and Philiberts, and Chouteaus, and Johnsons, and McGees, a little more than half a century ago. I have other evidences which will afford you glimpses of Man's presence here during this long intermediate interval of time. But how many races appeared and passed away from the scene is difficult to say, with the evidence now before us. Before the introduction of modern civilization, however, we have reason to believe that at least two races, differing in their habits and modes of life, were dwellers in our very fertile and picturesque hills and valleys.

I am indebted to Judge Ranson, of this city, for the information which led to the discovery of the specimens which I have the pleasure next to present you. The Judge superintended the widening of Twelfth street near its junction with Woodland avenue, in this city, several years ago, and in the excavation made for the purpose large quantities of flint chippings, arrow heads, stone axes and broken pottery were found at a depth varying from six inches to eighteen inches beneath the present surface.

The specimens taken out by him at the time, which amounted to the fourth of a bushel, unfortunately have been lost. One of them is described as being the half of a small pot or cup, capable of holding about a pint. This specimen had the appearance of being very recently broken, and was probably whole until the plow used in loosening up the earth for the excavation came in contact with it. I visited the place indicated the past summer, and was so fortunate as to find the specimens I have just presented you. The Osage Indians, I am informed by Mr. Johnson, occupied this place as a camping ground at the time of the first settlement of this country, and still used flint implements at this very recent time, so that we find flint chippings and arrow heads from the surface to a depth of about eighteen inches beneath. But we must not infer from this fact that they are all relics of the same race. For while the Osages used stone implements of the same style of art as those of earlier times, they knew nothing of the manufacture or use of the pottery we find lying in close proximity to them. It is difficult to say at what time these various deposits were made, or the number of different races associated with them. The flint implements seem to be of the same style of workmanship, all belonging to the paleolithic type; but the material used is widely different, while all of the specimens found at and near the surface are made from the common chert found in this vicinity, those of an earlier deposit, or many of them at least, have been fashioned from flint not belonging to this locality, nor within several hundred miles of here.

This latter class, or the material from which they have been made must have been transported from distant localities. There is yet another difference, that while the flint chippings and stone implements, including stone axes, have a wide range in this and the adjoining counties, buried at various depths near the surface, I am not aware that "prehistoric pottery" has been found except at this place, and in one place near the fair ground in Wyandotte county, Kansas. I am indebted to Mr. Winner, the efficient secretary of this academy, for information of this latter place. In company with him I recently made some researches there which resulted in our finding several fragments of pottery, in every way similar to that found in this county, which were, no doubt, deposited about the same time and by the same race of people. This latter array of specimens I also present for your examination. The earliest of the deposits, including the fragments of pottery and some stone axes of the neolithic type, may have been made soon after, or perhaps before, the completion of the bluff deposit. They are found resting almost, if not entirely, in contact with the upper surface of the Bluff deposit and imbedded in, or just beneath, the base of the vegetable mould overlying it. You will perceive from these fragments that there was at least two styles in construction, and as many as four different styles of ornamentation in the manufacture of the vessels of which these fragments are but the broken remains. One style of construction has a plain vertical rim at top about one inch in perpendicular height, from the base of which the bowl or body of the vessel gradually swells out in a convex form, terminating in an oval, diminishing downward, and perhaps slightly flattened at the base. The other style has simply a thickening or swelling out of the rim at top, and the bowl of the vessel is less convex than in the other. The ornamentation consists of indentations and punctures of various kinds upon the rim or around the base of the rim of the latter class; or it consists of engravings, traced before the hardening of the vessel, upon the outer surface, perhaps in imitation of a tree or plant. The vessels, judging from the curve of the broken pieces, would vary from one pint to several gallons in capacity.

The specimens I have described were found on a gradual slope of land, with but little elevation, reaching back from Jersey creek northwest, in Wyandotte county, and on a slope equally, but slightly, elevated, reaching back northwest from a branch of McGee creek, in this county.

So far as I know, artificial mounds have not been found in this vicinity, but farther investigation may disclose them.* In the meantime, with the evidence before us, we are not justified in assuming that the race that used and was associated with this pottery, was numerous or had a long existence here, for these relics are found, so far as I know, but at the two places indicated, and there confined to but very inconsiderable areas. * * *

* Since this paper was read, numerous mounds have been found in the vicinity of Kansas City, some of which have been described by Judge West.

THE EXCAVATIONS IN OLYMPIA.

There has been no flagging on the part of the Germans in their scientific investigations in the East, as witness her archæological researches in Asia Minor and Greece since 1871. The excavations in Olympia have opened a new era in the knowledge of the wonders of ancient Greece. Great and valuable riches have been dug up, and lately there has been a motion brought into the Imperial Parliament at Berlin for a new appropriation to continue these researches. To convince members of the importance of the work, the Government appointed Prof. Adler, who had been staying a long time in Olympia, to report to the Parliament what had been found at that place. The Professor says:

"The German Government had first to consider whether the undertaking would be of benefit to science, what would be the best way of carrying on the work, and the probable cost. After these and other questions of a secondary nature had been solved, the real business of excavation began October 4, 1875. The plain of Olympia is bounded on the west by the mountains of Druva; on the north is the woody Olympus chain, with the cone-like Kronos Hill standing out prominently, like one of nature's watch towers; on the south flows the many armed River Alpheios, and hurrying down from the north we have the brook Kladeos. The whole ground between Druva, Kronion and Alpheios, and far away into the Kladeos Valley is an alluvial soil of fine chalk and marl, with a slight admixture of clay which the Alpheios has spread over the plain in its headlong progress from the mountain lakes of Arcadia. The work at first did not progress so rapidly as it might have done, as the Greek Government were constructing a road from the place of excavation to the nearest harbor, and it was not till this was completed last year that our work could go on in peace. But in spite of this hindrance, casts of the treasures found were last year sent to twenty-seven art institutions, some in America and England. On the slope of the Zeus Hill were all the more important buildings, such as ten store-houses, several temples—among these the Temple of Zeus and two smaller ones in the same style, which when brought fully to the light of day will surely be found in good preservation, all with Doric columns; also ruins of brick erections, one a guard-room in which five men could stand. These latter are decidedly of the late Roman style.

"Alike in structure, and built of the same material as the brick ruins, are the sewers a little to the southwest of the temple. To the west of this is an ancient churchyard, a cemetery whose graves, formed of slabs of stone, have been many of them washed away by the Alpheios, and the arms of the warriors imbedded in the shallow shoals of the stream or in the wicker baskets of the fishermen. Since the discovery of these things the traffic which the fishermen of these coasts kept up in Greek bronze wares is accounted for, as also the presence of those articles in many art museums.

In the reports of 1875–6 there is a Byzantine church described as entirely covered with rubbish, partially excavated by the French, in 1829, and now completely bared to view. It was always thought that there lay a larger structure beneath, and this supposition is now confirmed. Besides a valuable treasure of well-preserved inscriptions and tombstones, there have been found on this spot some ancient ruins of a chapel surrounded by a wall or court-yard. By digging further still eleven large statues came to light—the Emperor Marcus Aurelius, his wife and daughter, the Emperor Commodus, and the family of the maker of these statues. We have by no means exhausted all that are there. Though they are only statues originated in the second century, and of no great worth as works of art, still they are interesting as portraits of Roman sovereigns, enabling us to learn much and to surmise more. But the grandest discovery of all is the Temple of Zeus, which in our wildest dreams we never hoped to find as perfect as it has shown itself. We see from the traces of charcoal that the temple was partially burned, and afterwards injured more or less by repeated shocks of earthquake. Even in the Christian age people had their dwellings round about it, but were driven away by earthquakes. Greeks and uncivilized tribes, probably Avars and Slaves, broke the sculptures to pieces and made their dwellings of them. The fall of the temple and the inundations of the River Alpheios, which did not occur merely in the spring, but lasted for ten or fifteen years, drove away these tribes, and the alluvial soil spread unmolested pretty equally over the whole upper surface. After the territory had been deserted for a while a second swarm of inhabitants settled there, of whom we know nothing except that they were even of a lower grade than the first, for their abodes were more miserable and more primitive than those over which they built. The reason that the first discoveries went on so slowly was because we deemed that the interests of science required us to preserve these ancient dwelling houses intact. But when we were sure that statutes lay beneath, short work was made of the housee, and the treasure below lay revealed.

One interesting discovery was the learning the name of the architect, Libon, and another the year of the erection—431. It is undoubtedly the most beautiful of all Doric temples known. It represents the last and best age of the heavy, bulky erections, as they were known in Sicily, while the more elegant ones were to be found in Athens. The material used in its construction was not a good sort—a kind of shell lime, done over with two thin layers of stucco, which was then painted. The interior arrangements are exactly as Pausanias and others describe them. Pausanias relates that the temple was adorned with sculpture. The twelve labors of Hercules were introduced, six over the principal door and six at the back. He further tells us that the two tympanums represent the last quiet quarter of an hour before the race of Pelops and the father of Hippodamia, the first-named winning by his cunning the four-horse race. The order in which the figures come, and their number, he likewise enumerates—Zeus in the center, then Pelops,

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Hippodamia, Kilias, the four horses abreast, the grooms (hippokrome), and last the river god Alpheios, under the figure of a man reclining to the right of Zeus, Oinamaos, Aerophe, Myrillos, again the four horses with two hippokromes, and the river god Kladeos. In this way Pausantas recapitulates twenty-one figures, viz: thirteen men and eight horses; and all these have been found, not perfect, it is true, but of each one some piece or other. Unfortunately, as yet only six heads have been excavated—three men's and three horses'. The reconstruction of the sculptures has been begun with great care, and it is pretty correctly ascertained to whom each separate little piece belongs. The lecturer was of opinion that the tympanum would have appeared to bare with only twenty-one figures, and doubts not that some accessory figures will turn up. Zeus, Pelops and Hippodamia have been found in tolerably large fragments. The discovery of the steeds tells us plainly how advanced the Greeks were in the technical parts of their subjects, and in perspective. The four horses abreast could not be allowed to occupy more space than a meter. The artist had depicted three in the back-ground in alto-relievo, close together, but the fourth, in advance, stands alone; and yet the group, as seen from below, has the effect of four horses close together, but free. The second tympanum, by Alkamenes, the pupil of Phidias, is in a much better state of preservation than the first. Only eleven heads, however, are forthcoming, which Mr. Newton declares to be the most beautiful and genuine of all we have of the Phidias school. The picture on the pediment is the moment when the Centaurs, heated with wine, begin to attack the Grecian women and virgins sitting near them. Of this west tympanum twenty-six different figures have been found in all. Thus the two tympana alone contain from forty to forty-four figures, undoubtedly of Greek origin, a colossal endowment to science, when we reflect that, of the 7,000 or 8,000 statues in Rome, not more than from 3,000 to 4,000 are genuine Greek work. Paris, London and Athens have few, indeed, to show. As regards the execution of these figures, we are too much accustomed to test all the Greek statues by what Phidias has done. The figures we have here are undoubtedly the work of great masters; but, as they were intended for particular niches, the side invisible to the spectator was left incomplete, while Phidias always worked up even those portions not exposed to view in the most painfully exact manner. All these statues gain immeasurably by being seen from the right height and light. Grecian art is only thus comprehensible in all its grandeur.

Then we have among our discoveries from five to twelve most excellent Metopes. Pausanlas mentions particularly the Atlas-Metope, which will come out in all its wonderful beauty as soon as the second cast of it has been completed. One of the first objects dug out was a Nike of Paionios, unquestionably the most complete piece of statuary yet found. It is the more interesting from having an inscription on it informing us of the name of the sculptor, and of the fact that his work carried off the prize from all other competitors. This Nike must have been placed here some fifteen

years before the temple was built. Even the French acknowledge that since the Venus of Milo nothing to equal it has been found. Moreover we have several bronzes, such as remains of tripods, coins, weapons. Of bronze statuettes there is only one large one. Still our bronzes amount to 1,000 or more, but mostly small pieces. Of these we may mention a bull's ear and horn the size of life, one of a lion in bronze relievo, statuettes of warriors, different bronze animals scarcely distinguishable—such as horses, swine. cows, etc., probably consecrated gifts from the pooorer inhabitants of the country in good harvest years. Among them, too, we have a griffin's or peacock's head in bronze. As duplicates of anything have to be divided between the Greek and German Governments, the Germans will certainly not get many of this collection. Numerous articles in terra cotta display rare perfection in form, preparation, and color, and lead to the supposition that the ancients must have well understood brick-making and burning."—*Globe-Democrat.*

THE NOTABLE ANTIQUITIES OF THE UNITED STATES.

Archæology is certainly on the advance. The recent researches abroad —at Cyprus, Mycenæ, Bologna; in short all over the earth—are stimulating inquiry and investigation nearer home, and the prospect is that we shall have something to interest us in our own prehistoric antiquities. The learned world hail with delight the wonderful discoveries of Di Cesnola. Schliemann, George Smith Wood, and other earnest explorers in the East, and the hope is that we are about to see active scientific interest directed towards our own archæology. All most certainly rejoice in the prospect of scientific progress in our land. The antiquities of America have been most singularly overlooked and neglected. For years the efforts of active investigators have been directed towards the development of our vast and almost wholly unexplored archaic field. The government has been solicited, Congress invoked, learned societies appealed to; but all in vain. Our people, ever ready to interest themselves in the antiquities of other lands, had but few words of encouragement for home explorers. Ample means could be raised, if necessary, in response to a cable telegram, to secure foreign antiquities, but not one dollar to purchase relics of the great unrecorded age —of that lost civilization which once filled the great valleys of the West. These facts are discreditable to our age, our people, and the government.

These reflections are due to the meeting of scientists in Boston recently to consider the importance of securing for Boston and the country the celebrated Dighton Rock, which has so long divided the attention of scientific men. It appears that the rock in question is in danger of being carried off by the King of Denmark, under some show of title conveyed years ago to the Royal Society of Northern Antiquities, Copenhagen. To prevent this, many of leading citizens of Massachusetts have concluded to initiate a movement as above indicated. Among those interested are President Eliot, of

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Harvard, Prof. Longfellow, Gov. Rice, Mayor Cobb, Thomas G. Appleton, John G. Whittier, James Russell Lowell, Rev. Dr. Vinton and Dr. Green.

What is the Dighton Rock? It is a huge granite mass lying on the east side of Taunton River, at Dighton, Mass., bearing an inscription in certain characters which have perplexed antiquarians and novices since 1680. A popular fallacy ascribes the inscription to adventurous Norsemen, who, about the year 1000 of the Christian era, visited the coast and have left the impress of their names and deeds, as it is claimed, at various points. This inscription has been variously pronounced Runic, Phœnician, Indian, etc. Copies were sent to the learned secretary of the society at Copenhagen, the late Prof. Rafn, who pronounced it: ("Antiquitates Americanæ") a Runic inscription dated back to the tenth century. Prof. Rafn appears to have been misled by the misquotation of certain characters—O R I N X—representing, as alleged, the name of one of the early Norsemen who navigated the waters about Martha's Vineyard.

A Phœnician origin has also been ascribed to "Writing Rock," as a monument of the earliest navigators of the remarkable maritime people who had passed the the Pillars of Hercules, claiming that the "pillars" occur among the sculptures on the rock. Notwithstanding all these diverse opinions of foreign savans and home archæologists, the true solution of the enigmatical inscription doubtless lies in the interpretation given by the late Mr. Schoolcraft, who construed the principal characters to be Indian, or more properly of an indigenous race—whether red men or some transitory type may not be determined. Rock inscriptions are not rare. They occur all over the country, from fartherest Main to the confines of our Western plains. They can not be traced to the same sources; many are due to the North American Indian, while others have a much greater antiquity. Recording upon stone is of very high antiquity. Ancient inscriptions are found all over the East.

Recurring to Dighton Rock, Mr. Schoolcraft, under the guide of Chingwaak, an Indian Chief, made it Muz-zin-na-bik, or rock writing of the Wabematais. The record denotes a battle, and was made by the victorious party. Washington, it has been stated, expressed the opinion while at Cambridge, 1789, that inscription was Indian. He had doubtless examined rock sculpture along the upper Potomac, Monongahela, and elsewhere in Virginia, and was familiar with this style of "rock-writing."

We present for the purpose of comparison several specimens of so-called Indian pictographs found on rocks in various parts of the country. These are properly Muzzinnabiks, representing both their glyphs and pictographs. The simpler forms of pictography are shown upon grave-posts. Painting upon scrolls of birch bark, skins, etc., is called kekeewin, or instructions.

Thoroughout New England numerous specimens of rock-writing occur. Dr. Green at the Boston meeting referred to several. In the State of New York there are others that could be mentioned. Along the St. Lawrence some occur, and even amid the granite folds of the Adirondacks rock-sculp-

turing has been noticed. On the Susquehanna, near Lancaster, Pa., "Indian Rock" is a famous locality. There are two—"Big and Little." The somewhat celebrated "Pompey" or "Oneida Stone," discovered in Onondago county, N. Y., is an object of antiquarian interest, but not of Indain or prehistoric origin. It is a gneissoid bowlder, 12 by 14 inches, and 8 in thickness.

Near Barnesville, O., are interesting rock sculptures. The location is near the line of the Central Ohio Railroad, west of Barnesville. Two massive sand rocks lie near the summit of a hill, and measure about ten by fourteen feet. Their exposed surfaces bear elaborate sculpturing. The work is *intaglio*, corresponding to this class of rock sculptures throughout the West.

Nearly opposite Buffington Island, in the Ohio, on the Virginia shore, may be seen at the low water an extensive rocky surface, bearing rude representations of animals, reptiles, birds, etc., including man himself. Of the reptiles well depicted is a saurian over ten feet in length. The power of the aboriginal sculptor has been elaborately displayed on this extensive rocky surface—one of the most interesting I have examined in the West.

"Antiquity," a few miles below, is the site of another sculptured rock which early attracted the attention of boatmen. Flood and vandalism have quite effaced most of the characters. On the Guayandotte, Great Kanawha, Sandy, and elsewhere in West Virginia, Kentucky and Ohio and are interesting sculptured rocks. To describe all would require a volume. Throughout the great West and Southwest we find sculptured rocks, on mountain, plain and estuary. There is a fine one in Georgia. It occurs on a granite bowlder, the characters being well cut. Passing to the far west are some rock carvings discovered on the face of a bold, lofty escarpment of coarse-grained sand rock, over 100 feet in height, on the Upper Missouri. About half way up are animals, symbols, pipes, implements, etc.

Recent explorations of the vast inter-mountain region of Colorado, Arizona, etc., have resulted in the discovery of interesting sculptured rocks in that part of our great domain.—*New York Graphic.*

UTAH MOUNDS.

We are kindly permitted, by a gentleman from this place, to make public the following interesting letter from a friend at Payson, Utah Territory:

SIR:—Your letter requesting me to furnish you information and a description of the Payson mounds, and the late discoveries made therein, I have received, and I herewith forward to you such knowledge of these ancient mounds as I possess. The mounds are situate on what is known as the Payson Farm, and are six in number, covering about twenty acres of ground. They are from ten to eighteen feet in height, and from 500 to 1,000 feet in circumference. For years farming was conducted on the land, and fields of grain were planted, grew and were harvested to the very base

of the homes of the mound-builders, the busy hard-working toilers of the field apparently caring little how or when they came here. About two years ago several of the residents whose curiosity had been arrested regarding the mounds concluded to explore their interior to see what could be found in the way of relics, and, perhaps, to find the glittering treasure that several spiritual mediums had said was hidden in one of the mounds. The explorations divulged no hidden treasure so far, but have proved to us that there once undoubtedly existed here a more enlightened race of human beings than that of the Indian who inhabited this country, and whose records have been traced back hundreds of years.

Last year, while engaged in excavating one of the larger mounds, we discovered the feet of a large skeleton, and carefully removing the hardened earth in which it was embedded, we succeded in unearthing an entire skeleton without injury. The human frame-work measured six feet six inches in length, and, from appearances, it was undoubtedly of the male gender. In the right hand was a huge iron or steel weapon, which had been buried with the body, but which crumbled to pieces on handling. Near the skeleton we also found pieces of cedar wood, cut in various fantastic shapes, and in a perfect state of preservation, the carving showing that the people of this unknown race were acquainted with the use of edged tools. We also found a large stone pipe, the stem of which was inserted between the teeth of the skeleton. The bowl of the pipe weighs five ounces, made of sandstone, and the aperture for the tobacco had the appearance of being drilled out. The inhabitants here say a race of people existed here 1,400 years ago, and belonged to a tribe known as the Nephites, who are often referred to in the Book of Mormons, which also speaks of terrible encounters these people had with their ancient enemy, the Lamonites. We found another skeleton near that of the above mentioned, which was not quite as large, and must be that of a woman. There was a neatly carved tombstone at the head of this skeleton. Close by the floor was covered with a hard cement, to all appearances a part of the solid rock, which after patient labor and exhaustive work we succeeded in penetrating, and found it was but the corner of a box similariy constructed, in which we found about three pints of wheat kernels, most of which dissolved when brought in contact with the air. A few of the kernels found in the center of the heap looked bright, and retained their freshness on being exposed. These were carefully preserved, and last spring planted and grew nicely, though the field insects seemed determined to devour it. We raised four and a half pounds of heads from these grains. The wheat is unlike any other raised in this country, and produces a large yield. It is of the club variety—the heads are very long, and hold very large grains.

We have found many curiosities in the mounds belonging to this ancient race once inhabiting this section. We find houses in all the mounds, the rooms of which are as perfect as the day they were built. All the apartments are nicely plastered, some in white, others in a red color; crockery-

ware, cooking utensils, vases—many of a pattern similar to the present age—are also found. Upon one large stone jug or vase can be traced a perfect delineation of the mountains near here for a distance of twenty miles. We have found several mill-stones used in grinding corn and plenty of charred corncobs, with kernels not unlike what we know as yellow dent corn. We judge from our observations that these ancient dwellers of our country followed agriculture for a livelihood, and had many of the arts and sciences known to us, as we found molds made of clay for casting of different implements, needles made of deer horns, and lasts made of stone, and which were in good shape. We also find many trinkets, such as white stone beads and marbles, as good as made now; also small squares of polished stones resembling dominoes, but for what use intended we can not determine. I have endeavored to give you a full description of the explorations so far, and as we continue will keep you informed.—AMASA POTTER, *in Eureka (Nev.) Sentinel.*

THE FAMOUS MOABITE STONE.

In the same room with Alfred Vicker's pictures is a very clever reproduction, by a lady, of the famous Moabite Stone, which was discovered in 1869. The original, it will be remembered, was found at Dhiban by Rev. F. A. Klein, a French clergyman, employed by the English Mission, in the possession of the Brue Hamajdah, one of the wildest Arab tribes, who had long kept it with great jealousy as being possessed of supernatural powers. All attempts to purchase the stone through native agents failed, and even the appeal to the Sultan did not suffice to give possession of it. In the end the Arabs, fearing that they should be deprived of it, determined to destroy it, and this they attempted to do by first heating it by a fire lit underneath it, and then, when it was red hot, throwing suddenly cold water over it. It was in this way effectually broken into pieces. But, fortunately, M. Clermont Ganneau, the learned philologist and now Professor at the Sorbonne, in Paris, had succeeded in taking what is called "a squeeze" or clay impression from the face of the stone, and after it was broken Capt. Warren, of the Palestine Exploration Expedition, took squeezes of the two larger fragments. The stone in fragments was eventually secured for the French Government, and after great care the recovered fragments were put together and the restored tablet now remains preserved in the Louvre at Paris. It measures four feet one inch in breadth, having an arched top and squared base, and being about ten inches in thickness. The model now exhibited is made to a scale of a quarter the size of the original, and evidently with the greatest accuracy that skill and patience could exert. The letters have each one been copied faithfully, and all the joinings of the fragments, where they show at all, so that we have before us in a portable form this priceless and most interesting relic. The letters are in straight lines across the face of the stone, and they are considered by the authorities in these

abstruse questions of paleography to be in the same characters as those used by David in the Psalms and by Solomon in his correspondence with Hiram, King of Tyre. To give some idea of the form of these letters, it may be said that they resemble rather our ordinary Arabic numerals, letters like the 6, 7, 4 and 0 occurring frequently, and others like our Roman Y and P. They are all incised, and appear to have been cut in by some hard and sharp tool. As to the date assigned to this record, which has been all read and translated by M. Clermont Ganneau, it has been confidently stated by the Count de Vogue to have been engraved in the second year of Abaz, King of Isreal. It is, therefore, older than the Homeric poems, as we know them through Homer, at least, and older than the famous inscription of Ashmunazar, probably 900 B. C. Although certain discrepancies remain to be cleared up, no doubt is felt as to general tenor of the inscription. A translation has been published, and may be obtained of the Palesine Exploration Society, and we presume, also, that copies of this excellent model may be obtained by those interested in this subject. At any rate, too much cannot be said in commendation of the great skill and patience devoted to this copy of the famous stone.—*London Times.*

INDIAN RELICS AT DAVENPORT, IOWA.

THE Indian relics discovered by the Rev. J. Gass in a mound near Davenport, Iowa, continue to evoke discussion. They consist of tablets of dark colored slate, with pictorial engravings, one of which represents a funeral pyre or a sacrifice, around which a dance is taking place; twenty-two stars and the sun and moon are also shown, and there are two lines of a written language in unknown characters. On the reverse of the tablet, which is rather less than a foot square and about one and a half inches thick, there are sketches of men, several quadrupeds (including two mastodons), some birds and trees. Another tablet has a dial, with four concentric circles, within which are marked the four cardinal points and twelve equidistant characters supposed to represent the signs of the zodiac. There is no doubt that these relics were found along with human remains, among layers of shell, in a mound. If put there for the purpose of imposture, they have been skillfully placed. All authorities agree that if the relics are genuine they are by far the most important archæological treasures yet found in this country.

MINERALOGY.

BITUMEN, ASPHALTUM, PETROLEUM, PYROSCHISTS AND CERTAIN OTHER SOLID HYDRO-CARBONS.

BY G. C. BROADHEAD, OF PLEASANT HILL, MO., LATE STATE GEOLOGIST.

[Read before the Kansas City Academy of Science, Nov. 28, 1876.]

In 1876 I was appointed as one of the judges of the Centennial Exhibition at Philadelphia, and as such I was assigned to write up a part of the exhibition, including the substances named at the head of this article. That article is included in the following pages, with but few additions and changes.

HYDRO-CARBONS

May be thus classified:

1. Gaseous hydro-carbons—Marsh gas, olefiant gas.
2. Thin oily hydro-carbons, as petroleum.
3. Thick oily hydro-carbons—Maltha or mineral tar, pittasphalt.
4. Solid Hydro-carbons, as asphalt, or pitch.
5. Cannel coal and pryoschists, or slate.
6. Bituminous coal.

BITUMEN—ITS EARLY HISTORY.

Anciently, far back in the remote uncertainty of time, we find that in the building of the tower of Babel "Slime had they for mortar,"* that the ark of Noah was coated within and without with pitch,† and we are further told in sacred writ "that the mother of Moses took for him an ark of bulrushes and daubed it with slime and with pitch."‡ In the latter instance the pitch was undoubtedly bitumen; in the others we infer that bitumen was also used, and there is no doubt of its being used in the construction of the tower of Babel.

Herodotus‖ informs us that the walls of Babylon were of brick laid in bitumen. It was heated and used as a cement in the place of mortar, and he also says that they mixed it with the tops of reeds and it was placed between every thirtieth course of bricks. His statements have mostly been confirmed by the observations of later travelers. Some state that they have found that bitumen was used in every seventh or eighth course, and at one place it was even found between every course of brick. Two kinds of brick appear to have been used at Babylon, one fire-baked, and the other sun-baked. Some were deposited in lime and sand, or only in clay, others in bitumen. Brick from Hillah, with bitumen still adhering to one side, were examined by Parkinson, and the bitumen was found to be still combustible and would

*Gen. xi, 3. †Gen. vi, 14. ‡Ex. ii, 3. ‖Clio. Book, I.

burn when brought into the flame of a candle, yielding a strong bituminous odor.* The village of Hillah, or Hellah, is said to occupy the site of the ancient tower of Babel, and the city of Babylon must have been on or near the present site of Hillah, which is known to have been built of the brick of the ancient city, and even may have been built upon the very site of ancient Babylon.† The bricks examined by Parkinson must therefore have been at least 3,500, or perhaps even 4,000 years old.

Bitumen flows out of the ground at Babylon. It is also dug up in Syria, but that used at Babylon was obtained at Hit, or It, or on the river Is, of Herodotus' eight day journey above Babylon.

Bitumen was also much used in building at other places. The wall of Media, between the Euphrates and Tigris, was built of burnt brick, laid in bitumen. We are also informed that the Persians would dip their arrows in pitch, light them and shoot on to the roofs of their enemies.‡

The Dead Sea, or Lake Asphaltites, is mentioned by most of the ancient writers as being very bituminous, and Diodorus states that near its middle a mass of bitumen would rise up every year and float off, appearing in the the distance like an island. This was gathered by the neighboring people, who carried it to Egypt and there sold it to the Egyptians, who used it in embalming their dead. In modern times the Arabs procure this bitumen from the shores of the Dead Sea and sell it at distant places.

Bitumen is spoken of by some of the ancient writers as pissasphaltum, and at Agrigentum it was burned in lamps in place of oil and called Sicilian oil.

PETROLEUM—ITS EARLY HISTORY.

Mr. Wm. Buck, Curator of Records of Pennsylvania Historical Society in an interesting article read before the society March 13, 1876, states that "the early French missionaries knew of its existence as early as 1627," and Charlevoix mentions that "in 1642 the Jesuits found near Lake Erie a thick oily stagnant water, which, on application of fire, would burn like brandy." Messrs. Dollier and Gallinee, missionaries of the order of St. Sulspice, prepared a map of the country in 1670, on which there is marked Fontaine de Bitumie, about where is now the town of Cuba, Allegheny county, New York. Charlevoix, who traveled through the country in 1721, mentions this water, which resembled oil and had a taste of iron. He also names another fountain containing similar water used by the savages to appease all manner of pains. Sir Wm. Johnson, who visited this region in 1767, mentions the fact of oil being upon the water, and *Spofford's Gazette*, May, 1822, mentions the Seneca oil spring at Cuba, N. Y. This spring is on a reservation of one mile square, belonging to the Seneca Indians, and the oil has been long known as Seneca oil. The earliest mention of petroleum in Pennsylvania was by Charlevoix, who obtained his information from De

* Parkinson, Organic Remains of a Former World. † Ib. Also Eng. Cycl., Nat. His. and Moore's Anc't. Min. ‡ Parkinson, Organic Remains.

Joncaire in 1721. Fort Duquesne was built in 1754; the commandant, soon after, in writing to Montcalm, speaks of observing astonishing wonders about three miles above Fort Venango, where he witnessed a religious ceremony of the Senecas. The tribe appeared very solemn, the great chief recited the conquests and heroism of his ancestors; the surface of the stream was observed to be covered with a thick scum, which at once burst into a complete conflagration. The oil had been gathered and lighted with a torch. At sight of the flames the Indians gave a triumphant shout.

Lewis Evans, a surveyor employed by the Proprietary of Pennsylvania to take geographical observations, in 1755, published a map which has "petroleum" marked thereon, near the mouth of the present Oil creek, on the Allegheny river.

David Zeisberger, a Moravian missionary, who visited the country of the Allegheny river in 1767, speaking of the oil springs, says, "that the Indians would dip off the surface oil, then stir the well, and when the water has settled, fill their kettles and purify the oil by boiling." He informs us that it was used by the Indians for toothache, headache, swellings, rheumatism and sprains, was of a brown color and could be used in lamps, and that it burned well.

Gen. Benj. Lincoln, in 1783, mentions the oil springs on Oil creek, Penn., and says, "that the soldiers bathed their joints with it and it afforded relief and freed them from rheumatic complaints; also that water impregnated with it operated as a gentle purge."

The proprietors of the *Columbian Magazine*, in 1787, published a map of Pennsylvania on which petroleum was marked near the confluence of Oil creek and the Allegheny. Since that time there has been frequent mention of Oil creek and the oil of this vicinity. Gideon C. Forsyth, in 1808, first mentions the occurrence of Seneca oil in Ohio, and Dr. S. P. Hildreth, in 1809, mentions its occurrence in the Muskingum valley. Gen. Lincoln, in 1783, speaks of a burning spring in Western Virginia, near which certain huntsmen had once camped, who, taking a brand to light them to the spring, a few coals were dropped upon the water and in a moment the water was in a flame, so that they could roast their meat as well as upon a hot fire.

Bituminous and burning springs were also mentioned by Thomas Jefferson and others as occurring on the Great Kanawha.

Near Scottsville, Ky., in early days, an oil (petroleum) was collected from springs and used for lighting purposes, and the Pittsburgh *Gazette*, in 1828, suggested that the city be lighted with petroleum.

On Oil creek, Pa., there are found old pits, cribbed in with timber, in which trees of several centuries growth are found, giving evidence of the ancient use of the oil. For many years the entire supply of naptha was obtained from the surface of these oil springs, and as late as 1859 Seneca oil was obtained in this way.*

*Wm. Buck.

The area over which petroleum has been found in the Eastern United States extends parallel with the Appallachians from New York to Tennessee, with an area of 3,115 square miles, of which only 39½ miles have produced oil in Pennsylvania.*

The best known and most prolific oil springs have been found on Oil creek, Venango county, Penn., and here, in 1859, were the first borings for oil. At 71 feet the first crevice was reached, and at 200 feet the second sandstone was passed through. In 1861, at 400 feet depth, the third sandstone was passed through, yielding oil. The Phillips well at that time flowed 3,000 barrels of oil per day, and soon after the Empire had the same flow.†

Salt was the precursor of the discovery of most of the oil wells. Numerous wells were sunk on Oil creek and vicinity, and the yield of oil became very great. The consumption was not equal to the supply and it sold at one time at ten cents a barrel. In 1861 it sold at twenty-five cents per barrel.

In 1864 the production had declined to 4,000 barrels per day and the highest price paid was fourteen dollars per barrel.‡

Prof. J. P. Lesley, in 1874, published an oil map, on which the following named oil regions are marked: The extreme northern in Kent, Bothwell and Lambion counties in Canada. Next commencing in Cataraugus county, New York, extending through McKean, Warren, Venango, Butler, Lawrence, Allegheny, Beaver, and terminating in Columbiana, Jefferson and Hancock counties, Ohio. A little further south an area includes portions of Noble and Washington counties, Ohio, with Wood, Pleasants and Ritchie counties, West Virginia. Another area includes portions of Perry, Athens and Meigs counties, Ohio. Then, at a long interval southwest, we encounter an oil district including portions of Allen, Wayne, Clinton, Barren, Adair, Cumberland and Monroe counties, Kentucky, with Overton county, Tennessee.

GEOLOGY OF THE PETROLEUM OF THE UNITED STATES AND CANADA.

We learn from the Canada geological report for 1863 that in Canada hydro-carbonaceous matter, probably derived from organic remains, is found from the base of the palæozoic rocks up, and in many instances it assumes the form of bitumen. Its presence is evident in the limestones and dolomites of the Quebec group and Trenton group, and in most of the palæozoic rocks. At Pakenham the large orthoceratites of the Trenton limestone sometimes hold several ounces of bitumen in their cavities, and at Montmorenci petroleum exudes in drops from the corals of the Birdseye limestone, but it is more abundant in the higher formations. The dolomites of the Niagara group, in the western basin, are more or less bituminous, and in parts of Western New York the limestones are so bituminous that when heated the bitumen is seen to exude from them.

*2d Geol. Surv. Pa., J., p. 1 and Seq., 1874. †Ib. ‡2d Geol. Surv. Pa., J., 1874.

Those of the corniferous are still more bituminous. Many fossils, chiefly of the genus Heliophyllum, are surrounded and their cells filled with bitumen. In some localities the bitumen is solid and assumes the form of asphaltum or mineral pitch.

According to Prof. James Hall, mineral oil is found in the septaria of the higher Devonian beds and also in the underlying sandstone of the Portage and Chemung group. The oil wells of Pennsylvania and Ohio are extended into the sandstones, but it is even probable that the oil may originate in the Cornifierous below. Prof. Newberry thinks the oil of Ohio and Kentucky is derived from Huron shales (Portage) at top of the Devonian, and that some of the Pennsylvania oil wells derive their supply from the same horizon. The wells of Western Canada, according to the Canadian geologists, issue from the Corniferous formation. At Enniskillen the borings extend 200 to 300 feet in the overlying Chemung and Hamilton shales, which have also 40 to 60 feet of clay and gravel upon them. The surrounding country here is generally level, and near Petrolia the overlying clay has a nearly uniform depth of 100 feet, beneath which the borings penetrate an average thickness of 380 feet of interstratified blue clay, dolomite, shales and marls of Hamilton and Chemung to the oil producing stratum. The theory is that the oil originates in limestones and is retained in a reservoir formed of the overlying sandstone.*

The petroleum of Athabasca and the northwest territory of British America occurs in Devonian shales and in large quantities.

On Oil creek, Pa., the chief oil producing rock is a third sandrock below the surface, and an oil producing spot in the Pennsylvania regions is an area overlying, from 500 to 1,500 feet, a bed of porous conglomerate from 3 to 75 feet in thickness, the thickest portion of the rock giving the best well, and the thickness is generally found in the center of the area, the rock tapering to the edges. The rock is considered the third sandrock, but we learn that it is not always continuous, but that there do exist detached beds of lens-shaped masses of third sandrock. This sandstone has been passed through at its greatest known depth, at 1,976, feet, and appears to be a white pebble conglomerate containing some green oil. In the same well (Jonathan Watson's) the next highest sandrock was at 1,507 feet, and was considered the true third sandrock.†

Prof. Lesley says that the Pennsylvania oils are not entirely confined to three oil sands, but extend through at least 3,000 feet of measures.

There are three chief oil sandrocks, all below the carboniferous strata. Some of the flowing wells have been penetrated to these lower sandrocks, and Prof. Lesley also says that the Canada oil bearing rocks pass under Lake Erie and are far below the Pennsylvania oil sands of the Allegheny river country.‡

The surface rocks of the oil wells of West Virginia are sunk in Carboniferous strata, but some of the oil is probably from below.

* Canada Geological Report, 1863. † Penn. Geol. Rep, J., 1874. ‡ Ib.

The black slates (Huron) of the upper Devonian of Ohio and Kentucky, according to Dr. Newberry, abound in hydrocarbonaceous matter and are undoubtedly the source of the oil supply.

STATISTICS OF PETROLEUM.

In Canada there are four areas, in which natural oil springs are found, two in Enniskillen, a third in Mosa and Oxford townships, and a fourth in Tilsonburgh. At the former wells have been sunk with great success. Near Oil creek, in Enniskillen, the thickened oil forms deposits known as gum beds of viscid, tarry consistency, and covering two or three acres of two inches to two feet in thickness. At Petrolia a bed of solid asphaltum two to four inches thick was found at ten feet depth in the clay, and sometimes hardened bitumen is found in cavities of the rock.

At Enniskillen the larger supply has been obtained from the deeper wells, and from some petroleum has risen above the surface of the earth. A well 200 feet deep yielded 2,000 barrels in twenty-four hours. Both oil and water flow out, and in some of the deeper it is saline. The oil area of Enniskillen covers about four square miles. The total oil producing area of Petrolia and Enniskillen is eleven square miles.* From a catalogue of Canada minerals, 1876, arranged for the Philadelphia exhibition, we learn that the borings in Enniskillen average 480 feet. At first the oil flowed spontaneously, but now the wells require pumping. There are at present 300 wells capable of producing petroleum, but only 200 are in operation, with between 200 and 300 steam engines used for pumping and boring. Only a small portion of the oil is distilled at Petrolia, but the greater part is refined at London, fifty miles east. At this place are fifteen refineries, with a total capacity of 12,000 to 15,000 barrels per week. The principal oil works here are the Atlantic Petroleum works, with Waterman Bros. proprietors. Their exhibition in the Canada section, Main building, Centennial, Philadelphia, was large and creditable. The catalogue of the Canada exhibit at the Centennial gives the amount of oil shipped from Enniskillen for the year ending January, 1863, at 82,814 barrels, of 40 gallons each, and the quantity refined in Ontario for the year ending June 30, 1871, 269,395 barrels; year ending June 30, 1872, 308,100 barrels; year ending June 30, 1873, 365,052 barrels; year ending June 30, 1874, 168,807 barrels; year ending June 30, 1875, about 210,000 barrels. The greater portion has recently been consumed in the dominion.

* Canada Geol. Rep., 1863.

H. E. Wrigley* furnishes the following statistics of production in the Pennsylvania oil regions:

Year.	Product in Barrels.	Average price per Year.	Amount in Dollars.	Barrels crude Exported.	Crude value of Export at Well.
1859	3,206	per gal. 31	$ 41,614		
1860	650,000	" 16	4,368,000		
1861	2,113,000	"bbl $2 73	5,770,128	27,812	$ 75,926
1862	3,056,006	1 68	5,135,098	272,192	457,282
1863	2,611,359	3 99	10,419,322	706,268	2,818,009
1864	2,116,182	9 66	20,442,318	796 824	7,697,319
1865	3,497,712	6 57	22 979,967	745,138	4,895,556
1866	3,597,527	3 73	13,418,775	1,685,761	6,287,888
1867	3,347,306	3 18	10,644,433	1,676,300	5,330,634
1868	3,715,741	4 15	15 420,325	2,429,498	10,082,416
1869	4,215,000	5 85	24,651,750	2,568,713	15,026,971
1870	5,659,000	3 80	21,504,200	3,530,068	13,414,258
1871	5,795,000	4 35	25,208,250	3,890,326	16 922,918
1872	6,539,103	3 75	24,521,636	4,276,115	16 037,475
1873	9,879,455	1 84	18,173,197	4,981,441	9,165,851
1874	10,910 303	1 17	12,765,054	4,903,970	5,737,644
	67,707,094	av. $3 48	$ 235 475,120	32,490,971	113.950,156

The *Engineering and Mining Journal* gives as follows: In 1875, 8,787,506 barrels produced; 1876, 5,023,351 barrels produced, (estimated).

In the Pennsylvania oil region there were drilled in 1869, 991 wells; in 1870, 1,007; in 1871, 946; in 1872, 1,032; in 1873, 530; in 1874, 433. Total drilled from 1869 to 1874, inclusive, 4,939, or in round numbers 5,000, producing 42,000,000. The average life of these wells is two and a half years.* On January 1, 1876, there were 3,314 oil producing wells in Pennsylvania.†

OTHER LOCALITIES OF OIL AND BITUMEN.

Ten years ago petroleum was known to exist in California, but only recently was it thought to exist in large quantities. But it is only found largely in the region of Lespe and San Fernando. The two districts of San Fernando and San Buenaventura are about fifty miles square. The San Fernando district is in the northwest part of Los Angelos county, lying on the foot hills and northeast slope of the San Gabriel mountains. The main belt of oil bearing shale can be readily traced in a width of 400 to 500 feet for about six miles northwest and southeast, between walls of sandstone, dipping southwest 32°. There are numerous wells, but the district as yet contains only one flowing well, yielding forty barrels daily. There is one refinery, which produces from the crude petroleum 60 per cent. of illuminating oil of 120° to 136° fire test, and 25 per cent. of fine-grained lubricating oil, the remaining 15 per cent. being fuel.

The district of San Buenaventura lies west of San Fernando and forty miles from Los Angelos and adjacent to the sea. It contains large petroleum springs, the oil of which floats off to the sea. The district has a re-

* Penn. Geol. Rep., J., 1874. † Eng. and Min. Journal.

finery, producing from crude 59 per cent. of illuminating oil of 130° fire test.*

Petroleum is found also in Asia Minor, Persia, Hindostan, Japan, and some portions of South America.

In New Zealand petroleum is obtained from Waipawa, Poverty Bay, Province of Auckland on the west coast, and Waipu, east coast. It escapes through cracks in trachyte breccia at Sugar Loaf Point, Taranaki. Wells have been bored several hundred feet deep but no steady supply obtained. Oil from this place was on exhibition at Philadelphia in the New Zealand section. The distilled oil has a specific gravity of 0.874 to 0.941. It is therefore not adapted for kerosene, which has a specific gravity of 0.810 to 0.820. The crude oil, of specific gravity .872 of 58° Fahrenheit, yields when distilled fine lamp oil 11.2 per cent., specific gravity .82. Inferior oil 37.75 per cent., specific gracity .858. Lubricating, 25.69 per cent. Paraffin 16 per cent. Bituminous residue 9.36.

OIL IN WESTERN MISSOURI.

Bitumen occurs in Western Missouri from Ray to Newton county, a distance of 175 miles north and south, and over a width of 25 to 35 miles, the rocks of the southern half being much saturated with it. From Bates county southwardly and extending westwardly into Kansas, tar springs are frequent. Although the rocks are often quite black with tar, and drops are seen oozing out and pools of liquid bitumen are sometimes found, still the quantity does not seem to be concentrated in sufficient quantities at any place to pay for the working. Its mere presence has occasioned the sinking of several deep wells, with no profitable results. There exists no positive anticlinals nor sinclinals in this district as there are in Pennsylvania, hence there is no room for basins for collecting the oil. Its greatest vertical extent in Missouri is 600 feet, it averages about 300 and lies chiefly in the lower coal measures, although extending nearly to the top of the middle measures. It is also found in the Lower Carboniferous limestones.

The bituminous sandstones very nearly resemble those exhibited at the Centennial from Werwohlen, Brunswick, Germany. An analysis of free bitumen from Oronogo, Jasper county, gave bitumen 95.75 per cent., ash (pale yellow) 4.25 per cent. Bitumen mixed with sand from Barton county, Mo., gave bitumen 44.74, ash 55.26.

In 1872 a boring was made near the Union depot, Kansas City, to a depth over 700 feet. Bitumen was found, and it is said that it rose to the surface from 180 feet depth and also from 291 feet. The geological horizon of the bitumen was evidently in beds of the thick shaly sandstone deposites of the Middle Coal measures, and undoubtedly of the same horizon as the bituminous sandstone of the Sander's well of Ray county. This latter well was bored 802 feet in search of petroleum, and proved to be a poor investment, as also did the well of about the same depth north of Richmond.

* R. W. Raymond, in Eng. and Min. Journal, January, 1877.

The well on McCausland farm, Lafayette county, was bored about 800 feet for oil, and after much attendant expense was abandoned. Bitumen here occurs in the upper sandstone of the Lower Coal measures. We know of oil and tar springs in Cass and Johnston, but in these counties people have wisely abstained from expensive search.

On Mormon fork, in Bates county, a well has been bored about 700 feet deep, but developed but little oil, although it proved of interest to the geologist and searcher for coal in proving the existence of two thick coal beds.

South of Butler, Bates county, is found a limestone with small cavities previously occupied by fossils, now filled with bitumen, and on Mulberry creek we find a four foot bed of very bituminous limestone. A similar rock is also occasionally found on the Little Osage river and Marmaton river near Fort Scott, and has been called Fort Scott marble, but is too hard to polish ever to be of much economic use.

On Shiloh creek, Vernon county, there is a small spring of clear water, but having a strong taste of petroleum.

In the southern part of Vernon and the northern part of Barton several wells have been sunk in search of petroleum. Many of the rocks of this district are so strongly saturated as to be quite black and are often quite tough from the cementing power of the bitumen, and some of the limestone beds, where convenient for transportation, may yet prove of value as material for street paving. In Europe such rocks are preferred.

Nearly all the coal and many of the rocks of Southwest Missouri, when freshly broken, give out an odor of bitumen. Bitumen is often quite abundant in the lead mines of Jasper county, intimately associated with the mineral.

OTHER BITUMINOUS ROCKS.

Certain thinly laminated rocks, ordinarily termed shales, or slates, occur in the Utica slate of the Lower silurian system, as wells as the Marcellus and Gennessee of the Devonian rocks of Canada and New York. It is well known that similar beds are of frequent occurrence in our coal measures in every State where coal is found. Dr. T. Sterry Hunt has appropriately termed them "pyroschists," and defines them to be argillaceous rocks containing, in a state of admixture, a brownish insoluble and infusible hydrocarbonaceous matter, altered to lignite or coal. Some of these strata contain, in the absence of oil wells, sufficient oil to distil for illuminating purposes.

There are thirteen bituminous shale beds in the Illinois coal field aggregrating thirty-four feet thickness.* In Missouri our estimate is twenty-one beds, with an aggregate of thirty-nine feet. This in a thickness of nearly 2,000 feet of coal measures. A few of these blend into a cannel coal, for instance certain beds in Johnson county and the Breckenridge coal of Kentucky. From the latter there was formerly distilled a good quality of illu-

*Ill. Geol. Rep., Vol. vi.

minating oil, in fact it was quite celebrated, but the discovery of the rich flowing wells of Pennsylvania suspended its production. The following table includes analyses of some of the the Kentucky pyroschists as determined by the Second Kentucky Geological Survey:

No.	County.	Thickness in Feet.	Specific Grav.	Moisture.	Vol. Comb.	Total Vol.	Coke.	Ash.	Carbon in Coke.	Sulphur.
1	Edmondson.....	6	1.362	0	59 7		40.30	26.		
2	Menefee	22		2 80	15.2	18	82 00	57.7	24.30	
3	Wolff.....		14.34	1.30	41.4		57.30	29.1	28.20	0 84
4	"	3	1.383	1.16	44.58		54.26	21.5	32 76	0 53
5	Breathett.....	3	1.36	1.60	43.2		55.20	21.4	33.80	2.55
6	McLean.....			1.60	36.4		62 00	30.64	31 30	
7	Mulhenburgh			3.56	13.68	17.24	82 76	75.94	6.82	

Specimens of these were in the Kentucky collection at the Centennial. Most of them are from the base of the coal measures. Number 1 is a cannel shale, which burns freely, is found under a considerable area in Butler county, and is six feet thick. No. 3 is also a cannel shale, which will form a pulverulent coke. No. 4 is also a cannel shale, over three feet in thickness, from Stillwater creek. No. 6 is from Wright's, on Frozen creek. No. 7 is a carbonaceous mud.

West Virginia, Pennsylvania, Ohio, Indiana, Illinois, Missouri, Iowa and Kansas abound in similar bituminous shales.

The bituminous shales of Collingwood, Ontario, when distilled, yield three to four per cent. of tarry oil, which, when rectified, affords illuminating and lubricating oil. The available shale bed is seven feet thick, and its geological position the Utica slate. The best bituminous shales at the Albert mines yielded sixty-three gallons per ton, and 7,500 feet of gas per ton. They belong to the Carboniferous.

NEW SOUTH WALES.

The Kerosene shale beds underlie a surface of six hundred square miles. Their geological position is in the Upper Coal measures. A section at Hartley Vale Kerosene Coal Company's mine, eight miles east of Bowenfels, gives:

1. (at top) 1 foot 6 inches fire clay.
2. One inch clay brand.
3. Three inches black casing.
4. Four inches impure shale yields forty gallons of crude oil.
5. Six to eight inches black shale.
6. One-half to eight inches band of inferior fuller's earth.
7. Eight inches ferruginous shale.
8. One-half to eight inches wet pipe-clay.
9. Three feet two inches kerosene shale, yielding up to eighty gallons refined oil per ton.
10. Ten inches "bottoms," yielding sixty gallons of crude oil per ton.

11. One-half to one inch yellow band of fuller's earth.
12. Bluish sandstone, with impressions of plants.

The *Glossopteris Browniana* is found in the above bed of kerosene shale.*

The kerosene shale occurs in even laminæ, is quite hard and breaks with a regular conchoidal to splintery fracture, with a shining surface. It is really a rich cannel shale. The Murrurundi Petroleum Oil Cannel Company work this shale, one hundred and thirty miles northwest from New Castle. At this place it is fourteen inches thick, resting on nearly eight feet of coal and clay. The proprietors are R. Towns & Co., of Sidney, who had an exhibition at the Centennial. The New South Wales Shale and Oil Company, of Sidney, had on exhibition a block showing the entire thickness. They undoubtedly possess the richest seam of kerosene shale; its greatest thickness is five feet, the middle three feet—the richest. They manufacture kerosene, lubricating and other oils from the mineral. The shale from the Hartley mine is shipped by rail eighty miles to the works, near Sidney, and is also exported for gas-making. An important locality is at the foot of Mt. York. Hundreds of thousands of dollars are invested in this industry, and the oil is used for illuminating purposes and gas-making, for which purposes it is chiefly exported to San Francisco, India, China and other places, but its chief exportation is to other Australian colonies and New Zealand. There is a slight import duty, but the Kerosene Company have possession of the market and control the trade. The shale yields 18,000 cubic feet of forty candle, or one hundred and sixty gallons of crude oil per ton, from a three feet two inch seam. On page 56, of Mines and Mineral Statistics of New South Wales is the following table of production of crude oil:

YEAR.	TONS.	VALUE, £.
1865	570	2,350
1866	2,770	8,154
1867	4,079	15,249
1868	16,952	48,816
1869	7,500	18,750
1870	8,580	27,570
1871	14,700	34,050
1872	11,040	28,700
1873	17,850	50,475
1874	12,100	27,300
Total	96,141	261,414

At Wollongong extensive works have been established for the manufacture of oil, and sometime since specimens of shale from Megalong and Illawarra were sent to Prof. Silliman, who applied to them the term Wollongonite, under the impression that they came from Wollongong. Oil has been made from this, but it does not yield so much oil as the Hartly shale.

*Mines and Mineral Statistics of New South Wales—Sydney, 1875.

ALBERTITE.

This remarkable mineral very much resembles the asphalt of commerce in being black, brittle and lustrous, with a broad conchoidal fracture; but it is less friable and its composition is also different, and it differs in fusibility and its relation to various solvents. The color of its powder is porcelain black, lustre resinous and splendent or shining, perfectly opaque, very brittle, odor bituminous; when rubbed is electric, burns and emits jets of gas in the flame of a spirit lamp, but does not melt like asphalt, but can be melted in a close tube. Under the microscope it presents no appearance of organic structure, and is free from mineral charcoal or impure coal. Its composition is, volatile combustible matter 57.20, ash in coke .27. It is found in King's, Albert's and Westmoreland counties, New Brunswick, and its position is in the Lower Carboniferous Coal formation, in calcareo-bituminous shales or pyroschists, which contain much bituminous matter, also many fossil fishes of the genus *Palaeoniscus*.* These shales have been much disturbed and contorted and, quoting from Dr. Dawson: "At the pit, the beds dip at angles of 50° and 60°, and near the bottom of the shaft consist of calcareous and ironstone bands and concretions. The Albert mineral occupies a vein in these beds, having an irregular high dip, preserving a general course of north 50° east to north 65° east, and at one place is as much as seventeen feet wide, thinning to one foot. Twelve hundred feet northeast it bends suddenly northwestwardly, the course bearing north 29° east for twenty-five feet, then returning to north 50° east. The vein has been worked to a depth of 1,162 feet, and occupies a regular fissure formed by an abrupt anticlinal or arching of the shale beds, appearing to be parallel to them, but its age is not therefore contemporaneous, for there are no stigmaria underclays which might be expected in a stratified coal bed.†

The mineral must have been, at some former time, in a liquid state and subsequently hardened, for a little is occasionally found in the spaces between the wall rocks.‡ Albertite in small quantities has been found at other localities—some of them fifty miles distant.

The chief export has been to the United States for making oil, and partly for admixture with ordinary bituminous coals in the preparation of illuminating gas. It yields one hundred gallons of crude oil to the ton, or 14,500 cubic feet of superior illuminating gas. The royalty paid to the government up to January 1, 1866, was $8,089.29, and the amount exported for twelve years, from 1863 to 1874, inclusive, 154,800 tons. The yield from the mine is now becoming less, and the probability is that it will be exhausted before many years.

GRAHAMITE.

This, sometimes called Ritchie Mineral, was discovered in Ritchie county, West Virginia. It occurs under similar circumstances to albertite and

* Acadian Geology, by Dr. Dawson. † Dawson, Acadian Geology. ‡ Ibid.

very much resembles it, and is used for similar purposes. It occupies a vertical crevice of four to four and one-half feet wide, occurring in the barren coal measures, above the horizon of the Pittsburgh coal. It has been worked, vertically, for three hundred feet and, horizontally, for 3,315 feet. The direction of vein is 12° north of west. It was undoubtedly first deposited in a liquid state, subsequently hardening. An analysis by Prof. Wurtz gives specific gravity, 1.145; carbon, 76.45; hydrogen, 7.83; oxygen, 13.146; ash, 2.26.*

MEXICO.

In the eastern part of Mexico, north of Vera Cruz, bituminous rocks occur, and some coralline limestones are thoroughly saturated with it. An asphaltum also abounds, which Prof. J. P. Kimball likens to Grahamite.

PERU.

At Caxitamba is a small pitch lake, the bitumen from which is found useful in stopping leaks of boats.

ARGENTINE REPUBLIC.

Liquid Bitumen occurs in large quantities. Kerosene oil is made of it.

CUBA.

There were several fine exhibits of asphaltum from Cuba in the Spanish section at the Centennial. The bitumen yields one hundred to one hundred and forty gallons of oil to the ton, and when purified is admirably adapted for lamps. Daddow and Bannon say that the chapapote or asphalt is mined, like coal, occurring in fissures in the rocks;† and flowing springs of petroleum are said to still exist in the vicinity, emanating from fissures extending to the underlying metamorphic rocks. The rocks of the whole island seem to be impregnated with bitumen, and there are numerous petroleum springs.

ISLAND OF TRINIDAD.

The wonderful Lake of La Braye, according to Parkinson, is one and a half miles in circuit, is hot at the centre but solid and cold towards the shore. Its borders, for a breadth of three-quarters of a mile, are covered with hardened pitch, on which trees flourish. At Point La Braye, the masses of pitch look like black rocks among the foliage, or as black vitrified rocks.‡ The lake is partly surrounded by mangrove swamps, excepting towards the sea, and what is remarkable, the lake itself is on higher ground than the neighboring swamps. Its outer margin is solid asphaltum, but further inwards the bitumen, of the consistency of thin mortar, is seen flowing, but in time hardens, and this outward flowing gradually encroaches on the harbor. The outer walls can be cut with an ax, and in appearance resemble an impure cannel coal, but are more gray. On some parts of the surface are seen thin pieces of black, shining asphaltum.

* W. D. Fontain, in American Journal of Science, December, 1873. † Iron, Coal and Oil—Daddow and Bannon. ‡ Organic Remains of a Former World.—Parkinson.

According to Gesner the surface of the lake is occupied by small ponds of clear water, in which are found several kinds of beautiful fish.* This remarkable lake is said to repose on recent Tertiary beds—Miocene and probably Pliocene. The odor of the mineral is apparent in the atmosphere, and it is asserted that it can be detected at eight miles distance. The bitumen, according to Gesner, yields by distillation a whole series of hydrocarbon oils, and gives seventy gallons of crude oil per ton of 2240 pounds. It is much valued for ship bottoms, and is reported to kill the teredo.

GERMANY.

The asphaltum of Werwohlen, Brunswick, is found in a sandstone which is said to be of Tertiary age. It very nearly resembles the bituminous sandstone of the coal measures of Southwest Missouri. It is used for roofing, for which purpose it is said to be well adapted, as it does not melt under ordinary sun exposure, and in the preparation seven-eighths inch asphalt is laid on three and one-half inches of cement.

SPAIN.

At Mastu, Vittoria, there occurs a fine-grained, black, bituminous limestone, and from it is made refined asphaltum.

SWITZERLAND.

The asphalt from Val de Travers has a world-wide reputation as a paving material. It is said not to crack in cold weather, being not affected by changes of the weather, nor does it possess a bad odor. Parkinson, in 1804, stated that on the south side of a mountain, the northern declivity of which terminates in the Valley of Travers, between Travers and Couvet, near to Neuenberg, there are two large pits containing asphaltum, which, in 1758, had been worked upwards of forty years. At the same height, on the other side, it was also found.

At Neuchatel it occurs, impregnating a limestone bed in the cretaceous formation, and serving as a cement to the rock, which is used for buildings. The rock is quite black and strongly impregnated with it. The Neuchatel limestone at this time (1876) has been worked for forty years, and is extensively used throughout Europe for paving and for roofing purposes. The principal agency is in London, but the asphaltum is used in all the chief European cities. In London it is found better to use it in a pure state. In Paris it is very much used, where it is mixed with rock. The Swiss Commissioner at the Centennial informed me that he had an acre paved with it at Neuchatel that had been in use for fifteen years without repairs. In Switzerland the preparation for roofing is generally: (1.) Flat tiles are laid in mortar on an inclined roof. (2.) Then pure asphalt is poured on to the depth of an inch. (3.) Then clean gravel is placed on the asphalt as closely as possible, causing it to present the appearance of a

* Coals, oils, etc., by Gesner.

gravel roof, or stone pavement. Asphaltum is also found in other localities in Switzerland.

OZOCERITE.

This is quite different in appearance yet closely related to the above. It is in part a native paraffin, has a general yellow or yellowish brown to dark color, and is of a waxy appearance—indeed it much resembles beeswax, especially when refined; is soft and easily pressed with the finger nail. Hoffstadster's analysis of two specimens give: A, with melting point of 61°, carbon 84.94, hydrogen 14.87; B, with melting point 65°, carbon 85.78, hydrogen 14.29.* It is soluble in ether, turpentine or naptha. The products are a wax or resin, both of a delicate white and yellow. Candles are made of it, but they do not possess a pleasant odor. It occurs in a bituminous clay, associated with calciferous beds, in the Carpatians; also in sandstone and shale of the Cretaceous formation, from forty to one hundred and sixty metres from the surface. The Ozocerite at the Centennial was from Boryslaw, in Gallicia. At this place it is associated with rock salt, asphaltum and fibrous gypsum, the latter penetrated by asphaltum. The annual production of Boryslaw amounts to 15,000,000 kilogrammes, worth eight to twenty kreutzers per kilogramme, or four and one-half to seven pence per pound. It is also found at Slanik, Moldavia, Gaming in Austria, in Transylvania, and at Uphall in Linlithgowshire, also near Lake Baikal.

COORONGITE, ELATERITE IN PART, OF DANA, ELASTIC BITUMEN—MINERAL CAOUTCHOUC.

Elaterite has been considered a carbo-hydrogen, near ozocerite, of which Dana gives carbon 84.3, hydrogen 12.5, the loss probably wholly or in part of oxygen.

Coorongite, in a condensed form, resembles crude India-rubber, occurring generally in sheets, varying in thickness from that of coarse brown paper to an inch thick, these evidently being the result of evaporation on the surface. It is found along the Coorong coast of South Australia, for over a hundred miles in length, and an average breadth of twenty miles.† Over this area it may be collected in drops, floating on the water of recently sunk wells, or in crevices of the underlying limestones, or in patches of various areas, from very small to several acres, of a leathery consistency, or else diffused through a diatomaceous earth, forming a black petroleoid matter. Bitumen is also found.

Coorongite burns freely with a reddish flame, melting like bitumen, emitting but little odor. It produces an oil, a tar, and a white wax, or paraffin, and has been made into a brilliant illuminating kerosene oil, said to be non-explosive, and not inflammable under a temperature of 150°. Considerable oil can also be made from the distillation of the soil of the district. Elastic bitumen has also been found in Derbyshire, accompanied

* Dana's Min., p. 732. † The country is mostly flat, with occasional swamps and some salt lakes.

with asphaltum; in a coal mine of Montrelais, a few leagues from Angers, France; also in a coal mine near Southbury, Mass.

Two substances, *Amber* and *Kauri Gum*, although very much differing from the above in their uses, yet are hydro-carbons. I therefore briefly notice them.

KAURI GUM.

[We possess no analysis of this, but it is nearly related, if not identical with Ambrits, of Dana.]

The *Dammara Australis*, or Dammara Pine, is a coniferous tree, common in New Zealand; also grows in the Molucca Isles and Amboyna. It is very resinous and quite valuable.

In New Zealand the gum is found in large quantities in a fossil state, occurring in the Tertiary formation (according to Dr. Hector, the Provincial Geologist), at depths from five to one hundred feet below the surface, and in amorphous masses weighing from one to three hundred and fifty pounds. Dr. Hector is confident that this gum has originated from the Dammara pine. Its color is grayish yellow, fracture conchoidal and of a glassy brightness. At ordinary temperatures it remains solid, but very warm weather causes it to become slightly flexible, and when rubbed it gives out a terebinthine odor. It is much valued for making varnish, being superior as an article for making furniture and implement varnish. It is valued according to color and purity. At Auckland the clear, cheap article bringing $90 per ton; the dark, clear and scraped $240, and the bold, bright, selected $300 to $350 per ton. The export from New Zealand, in 1874, was 2,600,000 tons; value, $440,000. It is largely exported to various countries, a great deal being brought to the United States. The gum and its various products were exhibited at the Centennial.

AMBER OR SUCCINITE

is a vegetable resin, altered by fossilization, sometimes inclosing insects which retain their perfect forms and appendages. It burns with a yellow flame, emitting an agreeable odor and leaves a black, shining, carbonaceous residue. Its composition is, carbon 78.824, hydrogen 10.228, oxygen 10.9. Its hardness, 2—2.5.*

Amber is harder than most resins and is susceptible of a good polish. It is used for necklaces, mouth-pieces for cigars and for varnish. It was known to the ancients and called *Electrum*, on account of its electrical susceptibility; it was also engraved and used by the ancients for seals.

It occurs abundantly on the Prussian coast of the Baltic, from Dantzig to Memel. It is also found on the coast of Denmark and Sweden; also in Gallicia, Poland, Moravia, the Urals, Switzerland, near Basle; France, near Paris; near London; in various parts of Asia, and in the green sand of New Jersey; also in Japan. It is chiefly obtained from Prussia, and is not very abundant in other countries.

* Dana.

THE ALKALINE AND BORACIC LAKES OF CALIFORNIA.

Immediately east of the range of the Sierra Nevada is an extensive region of alkaline lakes and hot springs, of which very large areas are almost totally barren, the only vegetation consisting of wild-sage, yucca, a few cacti, and scanty tufts of bunch-grass.

This district affords, in its many extensive craters and in its lavas, basalts, and obsidians, the most conclusive evidence of its volcanic origin, while its solfataras and boiling springs may be regarded as the last representatives of active vulcanicity. The region is one of great scientific interest, and, as it may eventually become industrially important, it has been thought that a brief description of the district, as well as of that of the borax-lakes, lying on the western side of the Sierra, might not be without general interest.

The most remarkable of the alkaline lakes of this portion of California are Mono and Owen's Lakes. The former lies in a depression occupying a portion of an elevated plateau of desert land, situated at the eastern base of the Sierra Nevada between the head-waters of Owen's and Walker's Rivers. The distance from the summit of the range to the lake-shore is about six miles, and the difference of elevation is about 6,000 feet. On all sides, excepting toward the Sierra, this lake is surrounded by a wide belt of desert, the total area of which is from 400 to 500 square miles.

Mono Lake is about fourteen miles long, from east to west, and nine wide, from north to south; but it was formerly much larger than it is at present; this is indicated by numerous terraces, by means of which the line of its ancient shores may be readily traced.

The water of this lake, which has a high specific gravity, and is alkaline and extensively saline, is not easily thrown into waves, but is generally smooth and glassy. Near its north shore there are springs which have produced extensive deposits of tufa, some of which rise several feet above the surface in forms resembling gigantic fungi.

There are numerous islands in this lake, two of which are of considerable size, the largest being two and a half miles long, from north to south, and the other about half a mile in length, from east to west. These, as well as a group of smaller islets lying to the north, are entirely composed of volcanic materials.

On the northeastern corner of the larger island are extensive hot springs and steam-jets, covering an area of some thirty acres, and extending into the lake. The escape of steam and hot gases from so many hundreds of vents is attended with much noise, and the sides of the orifices of many of the fumaroles are incrusted with a reddish-brown substance, which is probably chloride of iron. In the neighborhood of these springs there is a slight smell of sulphurous acid, but no free sulphur is deposited. Some of them furnish a copious supply of boiling water, large quantities of which enter the

lake, and so perceptibly raise its temperature for a considérable distance around. Much gas and steam escape from a fissure caused by the sinking of a portion of the crust, while on the eastern part of the island are two well-defined craters, now filled with water.

Mono Lake is, during the summer, the resort of myriads of gulls and other aquatic birds, which are most numerous during breeding-season, but the water is believed to be entirely destitute of life, with the exception of a small crustacean, *Artemia fertilis*, nearly related to the so-called brine-shrimp (*Artemia salina*) found in the strong brine of the salt-pans on European coasts, and the *Koo-cha-bee* of the Indians, a whitish larva, occurring in immense quantities, and which is much esteemed by them as an article of food.

Stretching south of the lake is a chain of extinct volcanoes, presenting the form of truncated cones, of which the generally steep sides are covered with ashes and other loose materials. Obsidian and pumice are abundant on the surface of these cones, and also cover the plains at their base.

Owen's Valley is a narrow basin lying south of Mono Lake, and running nearly north and south for a distance of about 140 miles. Its average width may be taken at ten miles. It is bounded along its western edge by the Sierra Nevada, which in this portion of its course presents an almost unbroken wall, of which the highest peak, opposite Owen's Lake, reaches an elevation of 15,000 feet. No pass crosses it at a less height than 11,000 feet, and near the lake shore the descent from the summit to the valley beneath must have an average inclination of at least 1,000 feet per mile, the distance being from ten to eleven miles, and the difference of level between the highest point of the pass and the valley being from 10,500 to 11,000 feet.

On the eastern side of this valley are the Inyo Mountains, toward its southern end, and the White Mountains further north. This range is dry and desert-like, and not a single stream of any size flows from it into Owen's Valley, which is exclusively watered by the melting of the snows accumulated during the winter months on the eastern slope of the Sierra. Owen's river rises a short distance from the source of the San Joaquin, and, after flowing for a distance of 120 miles, falls into Owen's Lake at latitude 36° 20′ north, longitude 118° west from Greenwich. This lake, of which the water is exceedingly saline and strongly alkaline, is twenty miles long and eight wide. It has no visible outlet, and its shores are often thickly coated with a snow-like alkaline incrustation.

No fish inhabits its water, but *Koo-cha-bee* is abundant, and at certain seasons is carried in by the waves and deposited on the shores in layers of several inches in thickness. This was formerly collected in large quantities by the Indians, and, after being dried in the sun, rubbed between the hands and roughly winnowed, was crushed in a stone mortar, and made into a sort of bread, which furnished an important article of food. This insect, which has been described as a white grub, is also found abundantly in the

waters of Great Salt Lake, Utah, and those of other saline and alkaline lakes of the West, and appear to be the larva of a two-winged fly which is described by the late Prof. Torrey under the name of *Ephydra Californica*, and by A. S. Packard as *Ephydra gracilis*.*

A specimen of water taken from Owen's Lake in January, 1866, had a specific gravity of 1.076, and contained 7128.24 grains of solid matter per gallon. The composition of this residue was found, calculated on an imperial gallon, to be as follows:

Chloride of sodium	2942.05
Sulphate of sodium	956.80
Carbonate of sodium	2914.43
Sulphate of potassium	122.94
Phosphate of potassium	35.74
Silicate of potassium	139.34
Organic matter	16.94
	7128.24

In adition to the substances above enumerated, iodine was present, but only in such minute proportions that its amount could not be estimated. It is also to be observed that since, for convenience of carriage, the sample of this water operated on was reduced by evaporation to one-fourth of its original bulk before being brought to this country for analysis, it is probable that some alkaline sesquicarbonates may have been originally present.

The incrustations which at certain periods of the year accumulate to the extent of many hundreds of tons on the shores of this lake mainly consist of carbonates of sodium, in which the proportion of sesquicarbonate is somewhat variable; in some specimens examined monocarbonates were alone present. Besides carbonates of sodium, these deposits contain three per cent. of chloride of sodium, and about five per cent. of sulphate of sodium, together with traces of silica.

It was proposed some years since to erect works on the eastern shore of Owen's Lake, for the purpose of refining this deposit, for the manufacture of merchantable carbonate of sodium; but whether this idea was ever carried out, I am not aware. The only serious obstacles to the success of such an enterprise would appear to arise from scarcity of fuel, and the great distance of the lake from a shipping-port.

As this lake continuously receives the waters of a considerable and constantly-flowing river, while it has no apparent outlet, it follows that it must act the part of a huge evaporating basin, in which the salts introduced by the not apparently saline water of Owen's River become concentrated to an alkaline brine. The rocks on either side of the valley through which the river flows are, to a very large extent, composed of granites, lavas, and basalts, from the decomposition of the feldspars in which the alkaline salts of the lake have doubtless been derived. The very small proportion of potassium salts present in these waters is remarkable, for although, from the cir-

* See Hayden, "Geological Survey of Montana, Idaho, Wyoming, and Utah, 1872, p. 744.

XUM

cumstances of the feldspars of the district being to a large extent triclinic, sodium might be expected largely to predominate, still so great a disproportion in the respective amounts of the two alkalies could scarcely have been anticipated. The circumstance may perhaps, to some extent, be accounted for by supposing the potassium salts to have been largely assimilated by plants during the percolation of the waters containing them through vegetable soil, while the salts of sodium, not having thus been arrested, have passed into the river, and thence into the lake.

Owen's, like Mono Lake, was at one time much more extensive than it is at present; this is evident from the occurrence of a series of parallel terraces, plainly traceable on each side of the valley. In addition to these lakes, numerous alkaline lagunes and boiling springs are met with throughout this region.

The *Artemia fertilis*, before referred to as being plentiful in Mono Lake, is also exceedingly abundant in Owen's Lake. A peculiarity of this crustacean is, that it congregates into masses which have often a strange appearance in the water. These masses sometimes stretch out in such a way as to have the form of a serpent, while at others they represent circles or various irregular figures. A gentle breeze scarcely affects water filled by *Artemiæ*, so that while on all sides the water is slightly ruffled, that which is occupied by these dense aggregations remains perfectly smooth, thus indicating the figure of the mass. On placing some of these crustaceans in a bottle filled with water, for the purpose of preserving them for subsequent microscopical examination, it was found that those which died rapidly disappeared, and on closely examining what had taken place, it soon became evident that as soon as vitality had ceased chemical action was set up, and the animal gradually disolved in the strongly alkaline brine.

Burton Springs are situated at the extreme northern point of Owen's Valley. These springs rise from the earth over an area of about eighty square feet, which forms a basin or pond that pours its heated waters into a narrow creek. In this basin a vegetable growth is developed at a temperature of about 160° Fahr., and is continued into the creek to a distance of about a hundred yards from the springs; where, at a temperature of about 120° Fahr., the algæ grow to a length of over two feet, looking like bunches of waving hair of a beautiful green color. Below the temperature of 100° Fahr., these plants cease to grow, and give way to a slimy fungus, which is also green in color, but finally disappears as the temperature of the water decreases. Dr. J. H. Wood, Jr., who has carefully examined this growth, makes the following observations with regard to it: "This plant certainly belongs to the *Nostochaceæ*, and seems a sort of connecting link between the genera *Hormosiphon* of Kützing and *Nostoc*.

"The best algologists now refuse to recognize the former group as generically distinct, and the characters presented by this plant seem to corroborate this view.

"The species appears to be an undescribed one, and I would propose

for it the specific name *Caladarium*, which is suggested by its place of growth."*

Twenty miles south from Owen's Lake across a sage-brush and greasewood waste, the surface of which is plentifully strewed with fragments of lava, pumice, and basalt, is Little Lake. This sheet of water, which is of comparatively small extent, is surrounded by huge masses of contorted vesicular lava, and evidently occupies the cavity of an ancient volcanic vent. The waters of this lake are considerably less alkaline than those of Owen's Lake, but bubbles of carbonic acid make their way to its surface in almost uninterrupted streams.

Fifteen miles east from this point are numerous hot springs; the path for the greater portion of this distance lies over lava-flows, which render traveling slow and fatiguing. At the principal group of springs the ground is covered, over a large extent, by innumerable cones of plastic mud, varying in height from a few inches to several feet; these rise above the surface of a seething swamp, and give issue to steam and jets of boiling water. In some cases the steam and gases, instead of issuing from cones as above described, are evolved under the surface of water and mud contained in basin-shaped reservoirs formed in the decomposed rock. By these means are produced multitudes of boiling caldrons in which violent ebullition keeps clay in a constant state of suspension; this clay varies in color from bluish gray to bright red. The waters of these springs are much employed by the Indians as an embrocation for the cure of diseases of the eye; on examination they were found to contain forty-eight grains of solid matter to the gallon, of which amount twenty-six grains are sulphate of aluminium; in addition they contain lime, soda, potash, and a little free sulphuric acid.

Borates of sodium and calcium occur in various localities in North America. The two borax-lakes are both situated near the shores of Clear Lake in Lake County, California, seventy miles northwest of the port of Suscol, and one hundred and ten from the city of San Francisco.

The larger of these lakes is separated from Clear Lake by a low ridge of volcanic materials loosely packed together, and consisting of scoriæ, obsidian and pumice; it has an average area of about three hundred acres. Its extent, however, varies considerably at different periods of the year, as its waters cover a larger area in spring than during the autumnal months. No stream flows into its basin, which derives its supply of water partly from drainage from the surrounding hills, and partly from subterranean springs discharging themselves into the bottom of the lake. In ordinary seasons its depth thus varies from five feet in the month of April to two feet at the end of October.

The borax occurs in the form of crystals of various dimensions, imbedded in the mud of the bottom, which is found to be most productive to a depth of about three and a half feet, although a bore-hole which was sunk near

† Silliman's Journal, vol. xlvi, 1868, p. 33.

its centre to the depth of sixty feet afforded a certain amount of the salt throughout its whole extent.

The crystals thus occurring are most abundant near the centre of the lake, and extend over an area equivalent to one-third of its surface; they are, however, also met with in smaller quantities in the muddy deposit of other portions of the basin. The largest crystals, some of which are considerably above a pound in weight, are generally inclosed in a stiff blue clay, at a depth of between three and four feet; and a short distance above them is a nearly pure stratum, from two to three inches in thickness, of smaller ones; in addition to which crystals of various sizes are disseminated through the blue clayey deposits of which the bottom consists.

Besides the borax thus existing in a crystallized form, the mud itself is highly charged with that salt, and, according to an analysis by Dr. Oxland, affords, when dried, in those portions of the lake which have been worked (including the inclosed crystals), 17.73 per cent. Another analysis of an average sample, by Mr. G. E. Moore, of San Francisco, yielded 18.86 per cent. of crystallized borax. In addition to this the deposit at the bottom of the other portions of the basin, although less productive, still contains a large amount of borax.

Water collected from Borax Lake, in September, 1863, was found by Mr. Moore to contain 2401.56 grains of solid matter to the gallon, of which about one-half was common salt, one-quarter carbonate of sodium, and the remainder chiefly anhydrous borax, equal to 535.08 grains of crystallized salt to the gallon. Traces of iodine and bromine were also detected. A sample of water taken from the interior of a coffer-dam sunk in the middle of the lake, and which has been allowed to fill by percolation from the bottom upward, was found to be more concentrated, yielding 3573.46 grains of solid matter to the gallon, but it contained the same ingredients, and in nearly the same proportions as the water from the lake itself. When evaporated to dryness, this water yields a considerable quantity of finely-divided carbon, resulting from the various organic bodies which have been dissolved in it.

Mud from the bottom of Borax Lake is in high repute among the local Indians as an *insecticide*, and is used in the following way: The head of the patient is thickly plastered with mud, which is well rubbed in, and then allowed to become perfectly dry; when dry it is removed by rubbing between the hands, and with it disappears the colony of parasites. Ordinary clay is, under pressure of circumstances, sometimes employed for this process of shampooing, but when alkaline or boracic mud is available, it is considered more efficacious.

When this locality was visited by me in 1866, borax was manufactured exclusively from the native crystals of crude salt, while the mud in which they were found was returned to the lake after a mechanical separation of the crystals by washing. The extraction of boracic mud was affected by the aid of sheet iron coffer-dams. The only apparatus employed consisted of a raft, covered by a shingled roof, provided with an aperture in its cen-

tre about fifteen feet square, above which were hung, by suitable tackle, four coffer-dams, each six feet square in horizontal section, and nine feet in depth. This raft, or barge, was successively moored in parallel lines across the surface of the lake, and at each station the four dams were sunk simultaneously by their own weight into the mud forming the bottom.

When they had thus become well imbedded, the water was baled out, and the mud and crystals removed, by means of buckets, into rectangular washing-vats, into which a continuous stream of water was introduced from the lake by Chinese pumps, the contents being at the same time constantly agitated by the aid of wooden rakes. In this way the muddy water continually flowed off, finally leaving a certain amount of crude borax at the bottom of each tank; this was purified by recrystallization. From the density acquired by the 70,000 gallons of water daily employed for this purpose, it is evident that only about one-half of the borax existing in the form of crystals was thus obtained, while the mud was again returned to the lake.

Instead of the coffer-dams, a small hand-dredging machine, worked, like the former, by Chinese labor, was subsequently introduced; but the mud brought up by it was subjected to the wasteful process of washing before described.

The crystals of crude borax thus daily obtained amounted to about 3,000 pounds; these were dissolved in boiling water, and recrystallized in large lead-lined vessels, from which the purified salt was removed to be packed into boxes, each containing 114 pounds, in which it was forwarded to San Francisco. The loss of weight experienced in the process of purification amounted to about thirteen per cent.

Shortly after my visit in 1866, the manufacture of refined borax at Big Borax Lake was suspended, and I am not aware whether it has been resumed, but the works do not appear to have been in operation in 1874.

Little Borax Lake covers an area of about thirty acres, and is usually dry during the months of September and October; it is then covered by a white crust, which is collected by Chinese laborers and carried to the works, where it is refined by recrystallization. *Ulexite*, a double borate of sodium and calcium, is brought to this place from Wadsworth, in the State of Nevada—a great distance, with several trans-shipments—to be treated at these works; it appears that on account of the presence of carbonate of sodium, and the cheapness of fuel, this can be done more cheaply here than in Nevada.

Clear Lake is a large and picturesque sheet of water, twenty-five miles long, by about seven wide, surrounded by mountains, which in many places rise abruptly from the water's edge. Boat-life on this lake is delightful; the water is smooth, there is usually a sufficient breeze for sailing, and should it fall calm, an Indian can always be hired to row.

Lying about a mile beyond the ridge which borders Borax Lake on the northeast, and at the foot of a shorter arm of Clear Lake, which extends off to the southward parallel with the larger one, is an interesting locality, known as the "Sulphur Bank." It is some six or seven acres in extent, and

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consists of a much-decomposed volcanic rock traversed by innumerable fissures, which has become almost covered by a large accumulation of sulphur.

From the fissures steam and gas are constantly issuing, and over and through the mass large quantities of sulphur have been deposited in such a way that at a short distance the whole bank appears to consist of this substance. Into some of these cavities a pole may be inserted for a distance of several feet, and they are often lined with stalactites and beautiful crystallizations of sulphur.

Sulphur is being constantly deposited, and its deposition is attended by the evolution of carbonic and boric acids. The gaseous matters issuing from these crevices appear to be the agency by which the various substances now deposited in the cavities have been brought to the surface. Sulphur is deposited on the sides of the various fissures either in the form of crystals or as amorphous, translucent masses of a beautiful yellow color. It is sometimes intermixed with cinnabar, the presence of which was first discovered by Dr. Oxland; but more frequently with minute cubical crystals of iron pyrites. Pulverulent silica, blackened by some hydrocarbon resembling coal-tar, is also frequently observed.

On the sides of the cavities colloid silica is found coating chalcedony and opalescent quartz in the various stages of formation, from the gelatinous state to that of the hardest opal. The indurated material is sometimes colorless, but is more frequently permeated by cinnabar and iron pyrites, or blackened by the tarry matter before referred to. Cinnabar is also found in laminæ, and occasionally even in veins and concretionary masses of considerable thickness.

In addition to being employed as a source of sulphur, this deposit has been worked for quicksilver, and has produced large quantities of that valuable metal.

On the shore of Clear Lake, near the sulphur bank, is a hot spring, of which the outlets, even when the water is low, are partially beneath the lake, so that the amount flowing from it cannot be ascertained. Hot water, however, rises through the sand at various points extending over a considerable area. A specimen of water collected by Mr. Moore from this spring was found by him to contain 184.62 grains of common salt, 76.96 grains of bicarbonate of sodium, 36.37 grains of free carbonic anhydride, 103.29 grains of borax, and 107.76 grains of bicarbonate of ammonium, in an imperial gallon; besides silica, alumina, and traces of various other substances.

Prof. Whitney remarks with regard to this spring: "The most extraordinary feature in the above analysis is the very large amount of ammoniacal salts shown to be present in this water, in this respect exceeding any natural spring water which has ever been analyzed. Mr. Moore thinks that, as in the case of the boracic-acid waters of Tuscany, ammoniacal salt may be separated and made available for economical purposes. This locality is

worthy of a most careful examination, to ascertain how considerable a flow of water can be depended on."*

Dr. A. Blatchly, of San Francisco, in speaking of the geyser group of quicksilver-mines, says: "Nearly all these veins contain iron in considerable amounts, frequently in sufficient quantities to constitute an ore of iron. Gold, silver, and copper, are also frequently constituents of these lodes, and occasionally chrome-iron in considerable quantities. But, so far as is known, in no instance have the precious metals been sufficiently abundant to pay for the expense of extraction.

"Bitumen is found in nearly all these veins, sometimes a deposit of a gallon or two in one cavity.

"Thermal springs are numerous throughout the whole quicksilver-region, and the uniformity of their occurrence leads prospectors to the belief that there is an intimate relation between the causes which generate thermal springs and produce deposits of cinnabar, and that where one is found the other may probably occur in the vicinity."†

On the eastern slope of the Sierra Nevada, near Walker's Pass, borax is found in what appears to be the bed of an ancient lake, large crystals of this substance having been met with in a hardened mud, exactly resembling those found in the blue clay of Borax Lake. By far the largest amount of borax is, however, obtained from the indurated mud, where it exists in common with other salts. This mud, from which borax is separated by lixiviation, contains about half its weight of that salt, and is a light, clay-like body, having a strongly saline and alkaline taste. The portion insoluble in water effervesces on being attacked by hydrochloric acid, and contains silica, alumina, lime, ferrous oxide, and magnesia. Similar deposits containing borax exist in Panamit and Death's Valley, in Lower Nevada; but these desolate districts have not as yet received so careful an examination as they deserve.

About twenty miles west of San Bernardino is the so-called "Cane Spring District," where ulexite or boronatrocalcite is found, over an area about ten miles in width by fifteen in length. The surface of the ground is covered by efflorescent salts, commonly known as "alkali," beneath which the borax salts (chiefly ulexite) are found at a depth of only a few inches.

At Hot Springs, in the northwestern portion of the State of Nevada, at a height of 4,500 feet above the level of the sea, and where the water issuing from the ground has a temperature of about 190° Fahr., there are deposits of boronatrocalcite, extending over considerable areas. Here, as far as the eye can reach, nothing is seen but barren mountains, formed of a black, porous lava; while the valleys are covered by an efflorescence of a mixture of common salt and sulphate and carbonate of sodium. In other cases the sands of these mountain-valleys contain deposits of more or less pure boronatrocalcite.

*"Geological Survey of California," p. 100. †"Mineral Resources west of the Rocky Mountains," 1875, p. 176.—Raymond.

Geysers and hot springs are numerous in the whole of this district, and from the number of extinct geyser-vents still visible they were probably, at one time much more numerous than at present.

The analysis of an average sample of the boracic material from Nevada afforded Mr. Loew the following results:

Boronatrocalcite	22.13
Chloride of sodium	2.80
Sulphate of sodium	2.62
Sulphate of calcium	6.17
Carbonate of calcium	3.01
Carbonate of Magnesium	.79
Clay	19 70
Quartzose sand	26.03
Water	15.04
Traces of potash, iodine, and loss	1.71
	100.00*

The purification of crude borax (*tincal*) is effected by a simple recrystallization, but the preparation of marketable borax from boronatrocalcite is attended with considerable difficulty, more particularly as the appliances available in the remote deserts in which it occurs are of the most primitive and limited description.

When boronatrocalcite is moderately pure it is first ground and subsequently dissolved in water, with the addition of an amount of carbonate of sodium sufficient to effect the decomposition of the calcic carbonate present.

The solution is subsequently heated, and the carbonate of calcium allowed to subside, when the liquor is drawn off, and, after concentration, borax is obtained by crystallization.

Unfortunately, this mineral often contains notable quantities of gypsum, which transforms an equivalent amount of carbonate of sodium into Glauber salt, a relatively valueless product. This salt is also frequently present in the material operated upon, and thus materially adds to the difficulty of treatment. In order to avoid these difficulties, it has been proposed to treat native boronatrocalcite with sufficient sulphuric acid to transform the whole of the carbonate of calcium into gypsum, and to liberate boric acid to be subsequently saturated by carbonate of sodium. Boronatrocalcite has also been treated with excess of hydrochloric acid, in order to obtain crystallized boric acid, but neither of these processes has hitherto afforded satisfactory commercial results.

The comparatively recent discovery of large quantities of this substance in Nevada will, no doubt, eventually, to some extent, affect the Tuscan producers of boric acid; but the fact that crude boronatrocalcite varies considerably in its composition, and that it is found in situations in which its local treatment would be almost impossible, has hitherto prevented this

* *Moniteur Scientifique*, 1876, p. 1,230.

mineral from being extensively employed as a source of commercial borax. —J. ARTHUR PHILLIPS, F. G. S., *in Popular Science Review.*

ASTRONOMY.

THE ASTEROIDS.

Every now and then the papers announce the discovery of a new planet. The occurrence indeed has become so frequent of late as to attract very little notice except from professed astronomers, and they, to speak the truth, are none too cordial in their welcome of the little strangers thus added from time to time to the already embarrassingly large family under their charge. For while these new planets are quite as troublesome to provide with ephemerides and orbits as their larger sisters, they are extremely insignificant as regards their importance in the economy of the solar system, being seldom more than forty or fifty miles in diameter and, as individuals, entirely without sensible influence upon the motions of other heavenly bodies. We say as individuals, because they belong to a numerous group known as the Asteroids (so called because they look like little stars), and the united attraction of the whole family does produce upon the orbit of Mars a perfectly sensible, though very minute effect, from which Leverrier has computed that the combined mass of the whole flock would suffice to make up a globe not exceeding one-third the size of the earth, and probably a good deal smaller.

At present the number of these bodies known is 172: the whole number existing is probably to be reckoned by thousands, since it would take more than five hundred of the largest of them to make up the mass named.

Ceres, the first of them, was discovered on the first day of the nineteenth century, that is, January 1, 1801.

It had been noticed nearly two hundred years before, by Kepler, that the progression in the numbers representing the distances of the planets from the sun is such as to suggest the existence of an invisible body in the space between Mars and Jupiter, and he at one time went so far as to predict its discovery. He abandoned the idea, however, supposing that in his celebrated but fantastic theory of the polyedrons he had found the key to the mysteries of the planetary system. Titius, in 1772, revived the original suggestion, and gave to the law of distances nearly the same form as that in which it was stated a few years later by Bode.

In 1781 Uranus was discovered at a distance from the sun so closely corresponding with the law as to satisfy astronomers that it could be no

mere accidental coincidence, and to confirm them in the belief that there must be a missing planet outside of Mars. The impression was so strong that an organization of twenty-four astronomers was formed by the exertions of Baron Zach, to search for it. Curiously enough, however, the good fortune of discovery did not fall to any one of their number, but to Piazzi, the Sicilian astronomer, who on the opening night of the century, in the course of observations for his famous star-catalogue, came upon a star of the seventh magnitude in a place where a short time before he was sure no such object existed. In a single day its motion was sufficient to prove its planetary character, and he continued to observe it, though much hindered by ill health and unfavorable weather, until it was lost in the rays of the sun. He was the only observer, however, for in those days communication was so slow that the planet had disappeared before the Continental astronomers could be notified of the discovery; and to find it again was hardly less difficult than at first. Gauss, then just beginning his career, came to the rescue with a new and entirely original method, by which from Piazzi's six weeks of observation he deduced the planet's orbit and computed an ephemeris by means of which Zach rediscovered it on December 31st, and Olbers independently on January 1st.

In searching for Ceres, Olbers had noted carefully the configuration of telescopic stars in that part of the sky where he expected to find her, and on reëxamining the region a few weeks later he was so fortunate on March 28th, 1802, as to discover another planet, Pallas. The existence of two of these little bodies suggested the hypothesis that they originated in the breaking up of a much larger body, of which probably numerous fragments must exist which might be found by careful search near the points where the orbits of Ceres and Pallas intersect. A search was instituted, and in 1804 Juno was discovered by Harding, and in 1807 Vesta, the only one ever visible with the naked eye, by Olbers. The hunt was kept up until 1816 but without result, as the observations did not include stars sufficiently faint.

About 1830 Hencke, postmaster of the little village of Driessen, took up the subject, and after fifteen years of patient searching was rewarded by the discovery of Astræa in December, 1845. The year 1846 was sufficiently signalized by the discovery of Neptune; but since then not a year has passed without adding to the roll of the Asteroids. In 1861 and 1876 each, 10 were discovered; in 1872, 11; in 1868, 12; and in 1875, 17.

The list of discoverers includes thirty-one different names: Fourteen of them stand credited with a single planet each, and ten with five or more apiece. Dr. Peters, of Clinton, New York, heads the list with twenty-six; Luther, of Düsseldorff, comes next with twenty; then follows Watson, of Ann Arbor, with nineteen, and Goldschmidt, of Paris, with fourteen. Fifty-two of these planets were discovered in France, fifty-four by American observers, thirty-nine by Germans, nineteen in England and its dependencies, and eleven in Italy and Sicily.

The orbits of these bodies have an average radius of not far from two hundred and fifty millions of miles, with a corresponding period of a little less than five years. But individual orbits differ widely from these figures. Thus Flora, the nearest to the sun, has a period of only 1193 days– a trifle over three years and a quarter—and a mean distance of only two hundred and two millions of miles; on the other hand Hilda, the most remote, has a period of 2868 days, or very nearly eight years, and the radius of her orbit is more than three hundred and sixty millions of miles. The orbits of the large planets are all nearly circular; many of the asteroid orbits, on the contrary, are very eccentric, resembling those of comets. Thus Æthra has an eccentricity of 0.38, which amounts to saying that her least distance from the sun is considerably less than half her greatest. The inclinations of some of their orbits are no less remarkable, that of Pallas being more than 34°, while that of Mercy is only 7°, and even that is altogether exceptional among the older planets.

As has been said before, the Asteroids are very minute, too small indeed to have their diameters determined with any certainty by direct measurement; we are limited to approximate results obtained by comparing their apparent brightness with that of planets whose size and distance from the sun are known. If we knew the reflecting power of their surface—their *albedo* as it is called—we could thus arrive at reliable conclusions; but wanting this element and being obliged to content ourselves with the mere assumption that this *albedo* does not differ much from that of the planet Mars, values inferred in this way must be accepted with a good deal of reserve. Littrow, Lespiault, and others have investigated the matter, and find that the diameters of the larger ones range from three hundred to one hundred and fifty miles, while the smaller ones lie between fifteen and thirty. They are so small that a good walker could easily make the circuit of one of these microscopic globes in a single day, and unless their density is much greater than that of any of the other planets, the force of gravity must be several hundred times less than that on the Earth's surface. A stone thrown from a boy's sling would fly off into space, never to return. We have spoken of them as globes, but certain otherwise unexplained variations in the brightness of some of them, especially Pallas, have suggested the idea that they may be irregular pieces of rock rather than spheres.

As to their origin two theories are held; one that they are the fragments of an exploded planet, the other that the ring of nebulous matter, which in different circumstances would, according to the nebular hypothesis, have formed a single planet like the others in the system, was in this case broken up, mainly by the action of the great planet, Jupiter, just outside. If the first hypothesis be so modified from that proposed by Olbers as to introduce the idea of a number of disruptions, first of the original planet and afterwards of its fragments, it becomes perhaps as tenable as the second, and there would seem to be at present no means of deciding between them.

The discovery of these bodies has hitherto been effected simply by patient and assiduous search. The asteroid hunter provides himself with charts of portions of the sky about 2° square near the ecliptic, so choosing his "preserves" as to have some one of them in convenient position for observation at all seasons of the year. On the chart he marks down all the stars visible with his instrument. The principle labor lies in preparing the charts; these once made, any interlopers are readily detected, and if planets (and not merely variable stars) their motion will reveal their character in a very few hours. The only remaining difficulty is to be sure that the object is really a *new* planet, and not one of the old ones, for it has happened more than once that a discovery announced with something of a flourish has had to be given up as a mistake for this reason. Hitherto there has been comparatively little difficulty in the matter, because the "Berlin Astronomical Year Book" has published each year ephemerides of all the planets whose opposition occurs during the year. But the labor and expense of the calculations has become so great on account of the increasing number, and the results are of so little importance to general astronomy, that it has been decided to give them up partially, and the ephemerides for 1877 contain the places of only 50 out of the whole 125 which come to opposition this year. This will often render it necessary, when a supposed new planet is found, to go through a long and laborious computation in order to make sure that it is not one of those already known. It is to be expected, therefore, that unless this difficulty is somehow met, the number of annual discoveries will greatly diminish.

The race between the planet-hunters is frequently quite exciting. It has happened several times that the same planet has been discovered by two or more independent observers on the same evening, and both Goldschmidt and Peters have been so fortunate as to discover pairs of planets at a single sitting; the latter has done it twice.

While these planets are personally, so to speak, of trifling account, very valuable results are obtainable from the study of their motions. An excellent determination of the solar parallax has been deduced by Galle from observations on the opposition of Flora. The most reliable value of the mass of Jupiter is that derived from the perturbations he produces upon the orbits of some of them. One or two cases of great prospective interest are presented, where the orbits of two of these bodies so closely coincide as to render it quite possible that some time they may, if they do not actually collide, come to move around each other in an oval orbit like that of a double star.

Minute as they are, they are not to be despised, and it is more than probable that in some way, though as yet beyond prediction, they will repay the labor spent upon them. Very few scientific facts remain forever barren.—Prof. C. A. Young *in Boston Journal of Chemistry.*

POSITIONS OF PLANETS FOR JUNE, 1877.

OBSERVATORY OF VASSAR COLLEGE.

The computations and some of the observations in the following notes are from students in the astronomical department. The times of risings and settings of planets are approximate, but sufficiently accurate to enable the ordinary observer to find the object mentioned. M. M.

MERCURY.—Mercury rises on June 1, at 4h. 19m. A. M., and sets at 6h. 29m. P. M. On the 30th, Mercury rises at 3h. 17m. A. M., and sets at 6 P. M. The best time for seeing the planet is on the morning of the 20th, when it is furthest from the sun and rises an hour before it.

VENUS.—On June 1 Venus rises at 4h. 57m. A. M., and sets at 7h. 57m. P. M. On the 30th, Venus rises at 5h. 41m. A. M., and sets at 8h. 35m. P. M. Venus is small but bright, and after the middle of the month it can be seen for nearly an hour after sunset, following almost exactly the path of the sun.

MARS.—On June 1, Mars rises a little after midnight and sets at 10h. 25m. in the morning. On June 30th, Mars rises at 11 P. M., and sets at 9h. 38m. the next morning. Mars is in southern declination among the small stars of *Capricornus* and *Aquarius*, but is moving toward the north, coming into better position and increasing in apparent size.

JUPITER.—Jupiter is brilliant now in the southern sky, and will be in its best position about the middle of June. On the 1st, Jupiter rises at 8h. 50m. P. M., and sets at 5h. 51m. the next morning. On the 30th, Jupiter rises at 6h. 41m. P. M., and sets at 3h. 41m. A. M. the next day. Jupiter souths at midnight on the 20th, at an altitude of 25° 10′ in this latitude. The various changes of Jupiter's four moons can be seen with a small telescope, and many of the most interesting occur in June. On the 12th, Jupiter will be seen with only three moons until after 9 P. M., when the 1st moon will reappear from behind the planet. On the 19th, the 1st satellite will disappear between 8 P. M. and 9 P. M., by passing behind the planet, and between 10 P. M. and 11 P. M. the largest will disappear by coming in front of the planet. On June 26, Jupiter will be seen when it rises, with all four moons; but a little after 10 P. M. the first will disappear by the planet passing between us and the moon and hiding its light; this satellite will reappear in 2h. and 24m., and for a little over an hour the four moons are still seen. But the 3d or largest is very near the planet, and a little after 2 A. M. comes in front of and is lost in the light of Jupiter. The small stars around Jupiter are those of the constellation *Sagittarius*.

SATURN.—Saturn rises on June 1st, at 1h. 5m. A. M., and sets at 0h. 23m. P. M. On the 30th, Saturn rises at 11h. 10m. P. M., and sets at 10h. 29m. A. M. of the next day. Mars and Saturn rise at nearly the same time on the 30th, but Saturn is 5° further north.

URANUS.—On the 1st, Uranus rises at 9h. 57m. A. M., and sets at 11h.

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49m. P. M. On the 30th, Uranus rises at 8h. 9m. A. M., and sets at 9h. 57m. P. M. Uranus is still among the stars of *Leo*.

SUN SPOTS.—The report is from April 17 to May 16 inclusive. In the photograph of April 17, there appears on the western limb the group of large spots mentioned in the last report; but from this date to April 21 clouds prevented observations, and during that time the group disappeared. On April 21, a pair of small spots was seen far advanced on the eastern limb. On April 22, this pair was followed by a pair of very small ones. During the passage across the disk, there was a continual change in the number and arrangement of the spots in these two groups. Before April 30, both had disappeared. In the picture of this date, a small group was seen on the eastern limb; but after May 5 it could not be found. When last seen, it was near the center of its course, but very faint. The observation of May 5 showed a small spot, followed by a very faint one. On May 4, these spots had not been seen, and were first visible on the western limb On May 8, a large spot was seen coming on. From May 8 to May 12 no observation could be made. On May 12, two large spots were seen near the center; one of these was seen before May 8, the other had burst out between May 8 and May 12. The one first seen on May 8 disappeared between May 13 and May 14 at about the center of its course; the other is still visible (May 16), and is at present preceded by a small spot not seen on May 15.—*Scientific American.*

ONE of the most remarkable appearances which has been seen on the planet Saturn since the time of Herschel, was noticed by Prof. Hall, of the United States Naval Observatory, on December 7. A spot so bright that it could be seen with small telescopes suddenly showed itself near the equator of the planet. It gradually spread out along the equator, so as finally to present the appearance of a strip extending over some 90°. The brightest part was not in the middle of the strip, but near one end, as if the shining material had spread itself out in one direction only. The discovery was at once communicated to several American astronomers, and the spot was observed at Albany, Hartford, Vassar College and elsewhere. It was watched during most of a month, when the planet approached near to the sun, and the band became so faint that no further accurate observations could be made on it. It does not appear to have been seen in Europe at all as the astronomical journals which have come to hand are entirely silent on the subject. The spot was utilized by Prof. Hall to determine the time of rotation of Saturn, which no one but Herschel had hitherto done. The result was about 10 hours 15 minutes, hardly a minute different from Herschel's estimate.

METEOROLOGY.

IMPORTANT BEARINGS OF METEOROLOGY ON AGRICULTURE AND HYGIENE.

The recent publications of the French Observatory of Montsouris (which is under the enterprising directorate of the *savant* just named) are highly instructive, as indicating some of the new directions in which meteorologists are working; and we will here invite attention more especially to two of these. The labors of Montsouris have elucidated the important bearings of meteorology at once on agriculture and on hygiene.

The proper object of agricultural meteorology is obviously to determine the influence of the various conditions of climate on vegetation. Everybody knows that heat, light and water are indispensable to a plant; but it is desirable to ascertain and define what part is played by each of these elements individually in the development of each plant, in each of its phases of vegetation, and in the formation of the various organic principles—starch, sugar, gluten, etc.—which it furnishes. On this problem the observers at Montsouris are busily at work noting the phases of vegetation, making "chemical analyses" of plants, taken periodically, so as to compare the progress of vegetation with the climatic conditions throughout the year, and analyzing the air and the rain with regard to the products they furnish to vegetation. This last point has excited no little interest lately. Nitrogen, of course, forms a large proportion of our atmosphere; but in this free state it does not appear capable of being assimilated by plants. It has to be offered to them in a state of combination, as in manures. Now the air often contains small quantities of natural manures of this character, viz., nitrogen compounds, which are supplied by the air to the ground; such are ammonia, nitrous acid and nitric acid. Whence they come seems still to be doubtful. There is some reason to believe that the ammonia of the air comes from the sea, and the traces of nitric and nitrous acid are said by M. Thenard to arise from electric discharges which traverse the air either in a silent and continuous manner, or in the form of sparks. Then M. Berthelot has shown that under the influence of atmospheric electricity the nitrogen of the air may be fixed directly in organic compounds of the ground, and that this fixation is favored by the development of certain microscopic plants. There is evidently here a wide field for scientific research, from which the art of agriculture may be expected to reap great benefit. The rain, too, is an instructive teacher. At Montsouris it is carefully analyzed from time to time, and (as an example of the results) it has been calculated that during the year September, 1875 to September, 1876, a total quantity

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of 1,363 grammes of ammonia was poured in rain on each square meter of the park of Montsouris, or more than thirteen kilogrammes per hectare. The quantity of other gaseous constituents carried down by the rain, and the irregular impurities it washes out of the atmosphere, are also recorded. The mention of impurities in the air naturally suggests the valuable services which meteorological research appears destined to render to public health. If air be drawn for some days through a tube containing carded cotton, the cotton will be found to have turned gray, through the powdery matters it has intercepted. Now these powders are well worthy of being studied. Their nature is very varied; they contain such material matters as carbonate of lime, carbon, iron, also the debris of fires, spores of cryptogamic plants, pollen, grains of starch, etc., and excessively minute grains which are probably the germs of living creatures. For more than a year these powders of the air have been subjected, at Montsouris, to daily microscopic analogy, and, in relation to the germ-theory of disease, which now engages so much thought, the results can hardly fail to prove of great value. It will be seen whether there is really a strict correlation between endemic or epidemic disease, and the frequency, local or general, of germs borne in the atmosphere. Perhaps it will be possible by and by to say what kind of germs produce particular kinds of disease, and to take protective measures accordingly. Indeed, not a little has been accomplished in this direction already, through the researches of Beale, Sanderson, Klein and others.

One of the means employed at Montsouris for collecting the organisms of the air consists in directing a slow current of air, produced by a small bellows, upon a drop of glycerine. In this way are especially caught the spores, pollens, particles of meteoric iron, starch grains, and debris of all kinds carried about by the wind. But the fine germs, which are of more importance, are apt to escape notice among the larger corpuscles; and, besides, in glycerine they lose the mobility which they show in water. So they are better observed in drops of water resulting from the condensation of atmospheric vapor, in night dew, in the first drops of rain, or in the dew which forms on the outside of a vessel with a freezing mixture in it; or, again, after washing the air with water from a spray-producing apparatus. Moving organisms, as has been stated, are often met with in such water, and their rotatory or irregular movements leave no doubt as to the real nature of these minute corpuscies; they are vibriones and bacteria. Sometimes, chiefly in February and March, minute colorless corpuscles, with a circular motion, are observed, which are thought to be mostly zoospores. Germs of infusoria are also frequently present. The spores of cryptogami become more abundant toward May.

Last year the municipal authorities of Paris, having decided that meteorological researches with reference to public health should be carried on in various quarters of the city, charged Montsouris to make arrangements for this purpose, and promised an annual grant of 12,000 francs. The new system, inaugurated this year, comprises at present twenty-one stations dis-

tributed over Paris. The principal object of the inquiries will obviously be the investigation of the relations between the general state of the public health and the impurities found in the atmosphere and in drinking water. The epidemic of typhoid fever which prevailed in Paris last autumn furnished the occasion for some preliminary researches of this kind, which M. Marie Davy has described to the Paris Academy. The experiments were chiefly made at the Price Eugene Barracks, which the war authorities had caused to be evacuated for disinfection. The water of an artificial dew got into the infirmary, which was inhabited several days before, was found very pure; but on scratching the floor of this infirmary, and of the rooms at different heights, a dark powder was detected, which, on being brought into water, showed a multitude of thread-like vibriones, having a slow, undulatory movement, and vibrating points which were rapidly displaced. The window sills of certain halls, particularly, gave an abundance of microscopic algæ, vibriones, bacteria, and monads. It is clear that when the troops were in the building these powders, raised by the tramping of feet and other causes, must have got mixed with the air that was breathed, and with the food and the drink. The ground of certain quarters of Paris contain them also, but in less quantities; but no trace of them is found in the subsoil, and the rooms of the Montsouris Observatory are also exempt. M. Marie attributes the epidemic in question to such living powders accumulated during summer on the ground and walls, and producing their morbid effects when the change of season rendered the conditions favorable.—*Boston Journal of Chemistry.*

A MIDSUMMER HEAT IN MAY.

For the past few days we have been experieneing a remarkable temperature for May. From a gradual and natural thermometric rise, which continued until the 9th, a sudden fall of temperature occurred. which brought back memories of winter and caused many to anticipate a rather late spring. On the 10th and 11th the thermometer at New York, where exposed in the afternoon to the air in free circulation, recorded only fifty-two degrees. At the same time of day on the 12th it rose to fifty-seven, and on the 13th to sixty-five degrees. But during these days it was noticed that a remarkable rise of temperature was taking place in the Northwest, where the pressure was low, as well as in the Southwest, where the heat of the afternoon had increased to over eighty degrees. At this time we received intelligence that a volcanic disturbance had occurred in the Pacific Ocean, causing a series of earthquake waves to break on that coast. The enormous liberation of heat resulting from this disturbance has undoubtedly much to do with the phenomenal temperature that followed. On the 14th, the isotherm of 70 degrees ran northward of the Middle and New England States and across the Lower Missouri Valley, but northward still, smaller

detached areas of high temperature were moving eastward. On the afternoon of the 15th the isotherm of seventy curved into Canada and across the lake into Dakota, giving Northern Minnesota a higher temperature than New Orleans. Thus the heat area became more clearly outlined and now covered the United States from the northern frontier to the Gulf. On the 16th the isotherm of 70 moved southward in the Northeastern districts, but still maintained its position in the Northwest. The heat decreased in Nova Scotia, the St. Lawrence Valley and Northern New England, but increased decidedly in the Middle States, the afternoon record at New York being 79 degrees. In Missouri a considerable variation of temperature took place, and a violent tornado resulted between Fulton and Alton. The heat in Wisconsin rose to 86 degrees, when it was only 71 at Cincinnati. On the 17th still more extraordinary variations occurred in the west, far northerly points being extremely warm, while more southerly places had comparatively cool weather. The temperature at New York fell to 76 and at Boston to 53 degrees. But yesterday it rose again here to the highest yet recorded, namely, 83 degrees, and still higher at Philadelphia, Pittsburg and Baltimore, being 92 degrees at the last named city. The great heat area is, however, passing off the continent; the temperature is falling rapidly in the North and Northwest, and though we now experience a midsummer heat, we shall after a few days feel proportionately chilly when the cool wave is passing over us. During the heated term here the temperature varied only slightly on the Pacific coast.—*New York Herald.*

EARTHQUAKE WAVES.—Assistant Davidson telegraphs C. Peterson, Superintendent of the Coast Survey, in relation to the earthquake waves registered in the tide guage at Port Point, at the entrance of San Francisco harbor, May 12, to the following effect: "Sharp earthquake waves commenced Thursday, May 10, at 6:18 A. M. Five rises and falls of 9 inches in eighty minutes; then nine maxima, or crests, forty-eight minutes apart, with secondary maxima, the largest 15 inches; then six sharp rises of 14 inches each; irregular, broken crests one hour apart; then, to 5 A. M. Friday, double maxima, as at the commencement; largest rise, 8 inches, from 5:20 A. M., Friday, to 1:15 P. M., irregular maxima; then a sudden fall to 16 inches, and action continuing until 5 P. M. No well defined maximum of action by expeditions of markedly different characters. The earthquake wave of the great earthquake in Japan some years ago was 23 minutes traversing the Pacific to San Francisco."

HYGIENE.

RELATION OF VENTILATION TO DRAUGHT.

Before concluding, I am desirous of considering with you an expression which is in general use, but the frequent cause of wrong views about the change of the air. I mean the word *draught*. All kinds of complaints are habitually ascribed to it, and the danger of draughts is one of the few hygienic principles which have become thoroughly popular. Perhaps this was not all profit, because with many people ventilation and draught are synonymous; they are afraid of a draught coming from an open window, an open door, and find themselves in collision with ventilation.

There is certainly and frequently danger in being exposed to a draught—a danger which has, perhaps, been over-estimated, because men have an irresistible desire to fix a certain cause for a certain evil. All collision is avoided if the proper meanings of *ventilation* and *draught* are thoroughly understood.

Ventilation is the necessary change of the air in a closed space, at which the velocity of the air is still taken for a complete stillness, and its motion takes place all around our body. It must not be more than a little above nineteen inches per second.

Draught is a one-sided cooling of the body, or some part of it, frequently caused by a corresponding motion of cold air, but also in other ways, as by increased one-sided radiation. The danger is, in the first instance, the local perturbation in our heat-economy, which has partly local consequences, but also and chiefly disorders the nerves, acting on the calibre of our blood-vessels, our vaso-motor nerves, which have to regulate the outflow of our heat. When we are in the open, and the air is in more motion than the air of a draught, we speak of wind, etc., but seldom of draught, because the whole air-current flows equally all round us, just as in a well-ventilated room, only with greater velocity.

The vaso-motor nerves, regulating the circulation in our skin, are beyond our control, and we cannot bid them to defend us simply at the place attacked by the draught. They know only how to serve our heat-economy when the outflow of heat from our bodies is equal, or nearly so, on all sides. They misunderstand the local irritation for one spread over the whole surface, and act at once on this error. If one perspires and goes to the window with bared neck or chest, one feels a shiver not only there but all over the body, and the perspiration becomes suppressed accordingly. The blood which at the time filled the blood-vessels of the glowing skin is displaced by the contraction of its channels; but by the misunderstanding of the vaso-motor nerves it is driven not only from the exposed parts but from the whole sur-

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face toward the internal parts. If one or some of them are in some state of weakness, danger or bad consequences cannot fail. It is the same thing as with a large quantity of cold water taken in too quickly when the body is heated. A draught, then, is injurious only in so far as it causes perturbations in our heat-economy, and as these pertubations can be caused in different ways we often accuse the draught wrongly.

We hear often, "I don't like sitting near this window, close to this wall," and so on; "there is always a slight draught coming from there." We fancy that we feel the draught, the motion of a wind, but it is mostly increase of one-sided heat-loss by radiation toward the cold place. People generally believe, rather, that the wind comes through the wall. But the velocity of such a wind is too small to be felt as air in *motion*, and a piece of carpet fixed to the suspected wall does away with the supposed draught. It could, therefore, not be caused by the air-rush through the wall, because the carpet is many times more permeable to air than the wall.

I hope, in future, ventilation and draught will be to your mind two distinct things.—PETTENKOFER, *in Popular Science Monthly.*

WHY NOT HAVE GOOD TEETH?

BY A. HOMER TREGO, D. D. S.

There is scarcely a subject of a personal character so sadly neglected and so little understood, by the people in general, as the care of the teeth.

In view of this fact, in 1869 the Odontographic Society of Philadelphia (about 100 members of eminent ability) offered a prize for the best essay on the subject; the same to be published for the benefit of the public.

The prize was awarded for the following:

RULES FOR PRESERVING THE TEETH.

1st. *Cleanse* your teeth once, or oftener, every day! *Always* cleanse them before retiring at night! *Always* pick the teeth and rinse the mouth after eating!

2nd. *Cleansing the teeth* consists in thoroughly removing every particle of foreign substance from around the teeth and gums.

3rd. *To Cleanse*, use well made brushes, soft quill or wood toothpicks, an *antacid, styptic toothwash and precipitated chalk.* If these means fail apply to a reliable dentist.

4th. *Always* roll the brush up and down lengthwise of the teeth, by which means you avoid injuring the gums and necks of the teeth, and more thoroughly cleanse between them.

5th. *Never* use a dentifrice containing acid, alkali, charcoal, soap, salt, or any gritty or powerful detersive substance.

6th. *Powders* and *pastes* generally are objectionable. They injure the gums and soft parts of the teeth, and greatly assist in forming tartar. *A*

wash, properly medicated and carefully prepared, is pleasanter and more beneficial. It dissolves the injurious secretions and deposits, and the whole is readily removed with the brush and water.

7th. *Avoid eating hot food!* Thoroughly masticate and insalivate the food before swallowing it. Frequent indulgence in sweetmeats, etc., between regular meals disturbs the process of digestion, and a viscid secretion is deposited in the mouth (from the stomach), which is very injurious to the teeth.

8th. *Parents!* Carefully attend to your children's second dentition. Gently prevail upon them, at an early age, to visit at frequent intervals, a careful and skillful operator.

Remember that four of the permanent double teeth come in at about the age of six years. They are very liable to decay early, are very large, and should never be allowed to require extracting.

Children do not "shed" their teeth as they did in former ages. Instead of being trained to masticate nutritious food, they are tempted with and allowed to "gulp down" delicacies, hot cakes, hot beverages, etc., Thus, by depriving the teeth of their natural function and overtasking the stomach, a morbid condition of the general system is produced; the "first teeth" are prematurely decayed, and the permanent set are not matured at the proper period of dentition. The consequences are terrible.

9th. *Never allow any one to extract a tooth*, or to dissuade you from having them filled, unless absolutely necessary. Many so-called dentists, actuated by selfish motives, advise extracting and sacrifice many teeth which competent operators can render serviceable for many years.

10th. *Carelessness and procrastination* are responsible for a large majority of teeth that are lost.

MARSH-FEVERS.—A substantial addition to our knowledge of the true nature of paludic fevers appears to have been made by Messrs. Lanzi and Terrigi, of Rome. Lanzi has found in the cells of microscopic algæ from the Roman marshes certain dark-green granules, which are most numerous when the plants are farthest gone in decomposition. At length these granules fill the cells, are black under the microscope, and the algæ emit an offensive odor. In the Campagna marshes are formed in winter, which in the spring develop algæ abundantly. In summer the water disappears, and the algæ then putrefy, the ground afterward growing phanerogamous plants. Toward the fall of the year the algæ in the parts still covered with water also die, and the slime at the bottom of the marshes contains quantities of the dark granules. The latter may also arise from other plants in the state of decay, even where there are no marshes. Lanzi regards these granules as a sort of ferments. Now, the pigment-granules found in the liver and spleen of individuals suffering from malaria have quite similar properties to those ferment-granules, and they can be developed quite similarly. M.

Terrigi has specially devoted himself to the means of disinfection, which may prevent the decaying process and development of the granules; he found chloride of lime, lime, and chloral, the most efficacious. With aspirators and air-filtering apparatus he ascertained that the germs rose to a height of fifty centimetres (about twenty inches) above the marsh-bottom, where they could easily be carried away by the winds. M. Terrigi found the "malaria-melanin" (as they call it) abundant in the liver and spleen of Guinea-pigs that had breathed the marsh-air for some time.— *Popular Science Monthly.*

SCIENTIFIC MISCELLANY.

CENTRAL AFRICAN HABITATIONS.

Commander Cameron, R. N, whose famous journey across Africa has proved so rich in valuable additions to our geographical knowledge of a little known portion of that continent, gives, in the record of his travels, the sketches from which the annexed illustrations are made. Both represent discoveries which will afford an excellent idea of the ethnological importance of a study of the people of Central Africa and their habits.

The explorer found in the curious village of Manyuema houses arranged in regular streets, and the latter kept scrupulously neat and clean. The inhabitants, although cannibals, are much more civilized than their neighbors, and appear to be a conquering race which enslaved the tribes of the vicinity. They are skillful iron workers, and erect furnaces which show considerable inventive ability.

It is well known that, in prehistoric times, whole villages were constructed on piles, above lakes. Relics of these villages have been abundantly found, belonging to extinct peoples representing all stages of civilization, from the age of stone down to the dawn of the iron age. It is not understood why the ancients adopted this form of habitation. Protection from hostile tribes, safety from wild beasts, and convenience in fishing, have all been suggested; but there are reasons which go to show that none of these explanations are entirely satisfactory. Commander Cameron has found the same species of dwellings in use on Lake Mohyra, in Central Africa. The inhabitants are excellent swimmers, and although provided with boats, frequently take to the water in preference to using them.

The lake dwellings are to be found in all parts of the world. The oldest known are in Switzerland, and in that country they have been thoroughly explored. They are of two kinds, those built of fascines and those built on piles. Those of fascines were commonly used on the smaller lakes of Switzerland, and wherever the bottom was too soft to hold a mass of piles

firmly; those of piles were built in deeper water, where the waves would sweep away a foundation of fascines. Lake dwellings as old as the stone age are found in some parts of Russia, and in Borneo and the Malay archipelago, as well as in Africa. Herodotus mentions them on Lake Prasias, in Thrace; and as these were connected with the shore only by a single narrow bridge, the inhabitants were enabled to defy the troops of Darius. Each family occupied one hut, and caught fish by letting a basket down through a trap door.

In Switzerland, large settlements of lake dwellings have been discovered in Lakes Zurich, Constance, Geneva, Neufchatel, and others; and from one in the little lake of Moosseedorf, near Berne, a vast quantity of very interesting relics of the stone age have been found, together with weapons and implements made of teeth and horns of animals, and fragments of pottery. A lake village at Robenhausen, in the Canton of Zurich, contains numerous dwellings, and it has been estimated that 100,000 piles of oak, beech, and fir were used in its construction; and three different sets of piles indicate as many different periods of construction. Wheat, barley, burnt apples and pears, beech nuts, cherry stones, fragments of cordage, and cloth of flax and bast, and stone relics, were found here in great profusion.

Similar structures have been found also in the lakes of Scotland and Ireland.—*Scientific American.*

AMERICAN INVENTIVE PROGRESS.

The future historian of the inventive progress of this country will find that the record of the same naturally divides itself into two distinct parts, each marking a separate era. These may be termed respectively the period of conception and the period of development. During the former most of the great American inventions were first originated; during the second, which includes the present time, the tendency of inventors has been more towards seeking new applications for established principles or improving upon earlier embodiments of the same.

The first era begins with the labors of Franklin, Rittenhouse, Hare, Evans, and their contemporaries. It terminates with the end of the year 1849. Inspection of the records of the Patent Office shows quite clearly the substantial basis for the division we have suggested. The first patent granted by the United States was dated July 31, 1790, and was issued to Samuel Hopkins for a process of making pot and pearl ashes. During that year the total number of patents was but three; the following year it amounted to thirty-three, and then for sixteen years the aggregate fluctuated, falling as low as eleven and reaching as high as ninety-nine. For the seventeen years following the variations were between one hundred and three hundred, the last mentioned number not being exceeded until 1825. The increase subsequently was more rapid; and by August, 1836, when the present system of numbering the patents began (it appears with those of

Thomas Blanchard, for turning irregular forms), the total had reached 10,041; or, for the period of sixty years comprised in the first era, the aggregate amounted to 17,447. Yet in this small number are included Whitney's cotton gin, McKean's first steam saw mill, Whittemore's wool and cotton card-making machine, Hare's oxy-hydrogen blowpipe, Blanchard's tack machine, Fulton's steamboats, Hall's breech-loading fire-arms, Perkin's steel engraving, Steven's tubular boiler and screw propeller, Lowell's power loom, Burden's horseshoe and spike machinery, Mott's stoves for small coal, Saxton's magneto-electric machine, Bogardus' ring flyer for cotton spinning and the long category of other important devices of that wonderfully prolific inventor, Professor Henry's splendid electro-magnetic discoveries, Morse's telegraph, Guthrie's discovery of chloroform, Boyden's patent leather, Baldwin's improvements in the locomotive, Howe's pin machine, McCormick's reaper, Colt's revolvers, Wells' hat body machine, Goodyear's vulcanization of india rubber, Bigelow's carpet loom, Howe's sewing machine, Sickel's cut-off, Morton's discovery of the anæsthetic qualities of chloroform, Rodman's hollow casting of ordnance, House's printing telegraph, and Ericsson's steam fire engine.

To show with what rapidity inventors made improvements on inventions embodying original principles, it may be noted that in the early days of the sewing machine one hundred and sixteen patents were granted for improvements thereon in a single year; and out of the 2,910 patents issued in the year 1857, one hundred and fifty-two were for improved cotton gins and presses, one hundred and sixty-four for improvements in the steam engine, and one hundred and ninety-eight for novel devices relating to railroads and improvements in the rolling stock. In the year 1848, three years after the publication of this paper was commenced, but six hundred and sixty patents were granted; but under the stimulus of publishing those inventions as they were patented, ten years later, in 1858, the number had increased six-fold, reaching 3,710, while up to January 1st, 1850, as already stated, the aggregate of patents issued amounted to 17,447; since that time and up to the present the total is 181,015.

Curiosity here leads us to review our own work, extending back for, say, twenty years, or to 1857, a period during which 170,745 patents have been issued. We find, by actual count, that 62,662 applications have been made through the Scientific American Patent Agency for patents in the United States and abroad. This averages almost ten applications per day, Sundays excluded, over the entire period, and bears the relation of more than one quarter to the total number of patents issued in this country up to the time of writing.—*Scientific American.*

BLUE GLASS PHOTOGRAPHY.

The blue-violet glass mania abroad seems to be confined to the photographers, and the conflict over the deceptive theory is being waged, not on

the question of the curative powers of the light transmitted, but regarding the assertion that increased chemical action can be obtained by glazing photographic studios with the cerulean panes. M. Scottelari, the blue glass defender abroad, has fallen into the same errors as his co-believers on this side of the Atlantic: that is, he confounds the blue-violet rays of the spectrum with blue-violet transmitted sun-light; while he also reaches the obvious absurdity that the violet ray, when isolated from the spectrum, possesses greater capabilities than it had when mingled with the other rays. It is perfectly true that the violet ray is more active, chemically, than the other rays; but the latter do not detract from it when combined with it, and the chemical action of white light containing violet rays is precisely as great as that of the violet rays separated and tested alone. Hence it follows, as a matter of course, that a window glazed with white glass transmits the whole of the solar rays which reach it, violet among the rest. A window of the same size glazed with violet glass would transmit one-seventh part of the rays reaching it, and these would be violet-colored rays; but it would not transmit one single violet ray more than the other window.

The *Photographic News* adds that, according to Draper and others, all the rays of the spectrum probably possess photogenic power on some substances; and therefore it is but just to M. Scottelari to conceive that he has found that the rays other than violet have an antagonistic influence on that ray, and obstruct its action on bromo-iodide of silver. But Mr. Thos. Gaffield, of Boston, has recently made some new investigations on this very point, wherein the inferiority of the violet glass to clear glass is most clearly shown. Mr. Gaffield's conclusion relative to the photographic aspect of blue glass accords with our own relative to its employment for curative purposes. He says: "It is undoubtedly true that violet or other colored screens may be used with advantage in cutting off too much, or in making an even diffusion of, light upon the face of the sitter; but it can never be true, while two from six leave a less number than six, that the cutting off of a third, or any fraction, of the chemical rays of sunlight by a violet glass can enable the photographer to obtain more rapid or effective results."—*American Chemist.*

A SILK-SPINNING FISH.

There is a mollusk—the *pinna* of the Mediterranean—which has the curious power of spinning a viscid silk which is made in Sicily into a textile fabric. The operation of the mollusk is rather like the work of a wire-drawer, the substance being first cast in a mould formed by a sort of slit in the tongue, and then drawn out as may be required. The mechanism is exceedingly curious. A considerable number of the bivalves possess what is called a *byssus*, that is, a bundle of more or less delicate filaments, issuing from the base of the foot, and by means of which the animal fixes itself to foreign bodies. It employs the foot to guide the filaments to the proper

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place and to glue them there; and it can reproduce them when cut away. The extremity of the thread is attached by means of its adhesive quality to some stone; and this done, the *pinna*, receding, draws out the thread through the perforation of the extensile member. The material when gathered is washed in soap and water, dried, straightened and carded—one pound of course filament yielding about three ounces of fine thread, which when made into a web, is of burnished golden brown color. A large manufactory for this material exists in Palermo.—*Scientific American.*

A NEW USE FOR ASBESTOS.—Some experiments have recently been successfully made in Italy on a new way of burning petroleum under steam boilers. The method consists simply in pouring the oil over a thin layer of asbestos. The petroleum burns with an intense heat; while the asbestos, being incombustible, is not affected, and thus not only serves as a means of retaining the oil, but, being so good a non-conducting substance, the prevention of fire from the volatile oil is obvious. In the experiments, sheets of paper placed beneath the furnace were not injured, despite the fierce incandescence of the oil above.

EDITORIAL NOTES.

KANSAS CITY ACADEMY OF SCIENCE.

At the annual meeting of the Academy of Science, held May 29th, in the rooms of the Young Men's Christian Association, the following officers were elected for the ensuing year.

President—Hon. R. T. Van Horn.

Vice President—Judge E. P. West.

Recording Secretary—W. E. Winner.

Corresponding Secretary—Col. Theo. S. Case.

Treasurer—Dr. Geo. Halley.

Librarian—Harry H. West.

Member of Executive Committee for four years—Dr. Geo. Halley.

A resolution was passed requiring all members reading papers before the Academy to file written or printed copies with the Librarian for preservation

At the next regular meeting, on the evening of the last Tuesday in this month, a paper upon the "Remedial Properties of Heat" will be read by Prof. Geo. Halley, of this city. At the regular meeting in July an archæological article will be presented by Judge E. P. West, and for that of August, Prof. T. J. Eaton will prepare an appropriate essay, the subject of which has not yet been made known.

WESTINGHOUSE AUTOMATIC AIR BRAKE ON THE KANSAS PACIFIC R'Y.

On the 22d of May a series of tests of the Improved Westinghouse air brake was made near this city by the Kansas Pacific Railway Company, under the management of S. T. Smith, Auditor, and D. E. Cornell, General Passenger Agent. The results we give below in the report of the committee appointed for the purpose:

We, the undersigned, having been requested to act as a committee to observe, record and report the results of certain tests of the workings of the Westinghouse Improved Automatic Air Brake upon a special train fitted for the

purpose on the Kansas Pacific Railway, submit the following report:

On Tuesday, May 22, 1877, a train consisting of five passenger cars, two baggage cars, with locomotive and tender, weighing in the aggregate 357,430 pounds, and carrying one hundred and thirty-five passengers, was taken to a piece of level track, about five miles west of the city, and subjected to the following test, viz.:

1st. The engineer was directed to run at the ordinary speed of twenty-five miles per hour and to apply the brake while under such headway, so as to ascertain the time required to bring the train to a full stop and the actual distance run after such application.

2d. Same as the above, except that the train was run at a speed of thirty miles an hour.

3d. Same as before, except that the train was run at the highest possible rate of speed.

4th. Test of the automatic action of the brake by causing the coupling pin between the locomotive and train to be removed while the train was in motion.

5th. Test of the value of the brake in case of fire or other accident when the bell cord fails to notify the engineer, made by applying the brake from within one of the cars while the train was in rapid motion.

6th. Test of the rapidity with which a train may be stopped and backed up to avoid a collision with another train.

DISTANCES.—A distance of one-eight of a mile was first marked off, then one of 300 feet, then seven others of 100 feet each, all plainly and prominently designated with bright colored flags and boards.

Time-keepers were selected and properly stationed, and at about 2 P. M. the tests were made in the order above mentioned with the results given below, viz.:

No. of Test.	Rate of Speed. Miles per hour.	Distance run after Application of Brake in feet and inches.	Time run after Application of Brake.
1	25 5-7	217 feet.	10½ sec.
2	31	298 "	11 "
3	38	387½ "	12 "
4	40	369 "	11 "
5	44	494 "	16 "
6	30½	*395½ "	56 "

*This distance includes the forward run as well as the backing up, and the time also covers both motions. The rate of speed in backing was ten miles per hour.

We consider the results very satisfactory and gratifying, and find, upon comparing them with those of the competitive trial on the North British Railway, in 1876, that, other things being equal, the stops were made in less time in every single instance.

THEO. S. CASE,
H. J. LATSHAW,
M. W. ST. CLAIR. } Com.

ENGINEERING IN THE ROCKY MOUNTAINS

[Correspondence.]

The Colorado Central Railroad Company, a corporation now operating a system of narrow gauge railroads in the Rocky Mountains, in connection with the ordinary 4 foot 8½ inch gauge, have inaugurated a special system of narrow gauge railway, by which to overcome and to surmount mountain summits too steep to be overcome by ordinary grades, in the usual manner. The problem presented is, to build a narrow gauge track from Black Hawk to Central City. The distance between the present terminus, at Black Hawk, and Central is one and a half miles. The elevation at Central above the Black Hawk depot is five hundred feet, vertical, which would give for a direct line a grade of three hundred and seventy-five feet per mile, which, of course, is not possible, as the bare locomotive could not haul itself up with its tender.

To overcome this difficulty and to lengthen the line sufficiently to reduce the three hundred and seventy-five feet grade practicably, the line is laid and located along the side of the mountain, southeast from Black Hawk, with a steady ascending grade of from one hundred and fifty-eight to one hundred and seventy-two feet per mile, terminating in a piece of level track three or four hundred feet long, upon which the train can halt. Where the ascending grade changes to a level grade a switch is placed, which moves the switch-rail to another track, which, in the same manner, ascends in a reverse course, and above the first track ascending from Black Hawk. This second ascending track winds northwest along the high mountain slope until it reaches an altitude sufficiently high to extend, with some six hundred feet of level grade, into the upper end of Central City, in Nevada Gulch, some 8,500 feet above the sea. In this part of the line, or

"switchback," as it is technically called, this miniature railway crosses, in two miles length, some sixty different gold and silver mines, now being developed, and threads its devious way among a maze of shafts, pits and tunnels too numerous and too frequent for the easy prosecution of the construction party.

The view developed from these high mountain peaks will be extended, novel and of deep interest. Some twenty miles northwest we are, on a portion of this railway, faced by the high, steep face of James Peak, over 13,000 feet above the sea, while just below us we look into the chimneys, the yards and the busy streets of Black Hawk and Central City, while again to the east we see high, woody mountain ranges and a distant view of the sea-like prairies. Opposite, the mountain sides are seamed with galleries, open cuts and the broken fragments of years of active prospecting and profitable mining.

This railway is being built with great care. Its track will be wide, solidly built, and of unusually carefully selected materials, for this special purpose; rails to be fifty pounds to the yard, and it is to be provided with locomotives that can ascend with four or five cars to Central City, at the rate of eight miles per hour. All to be completed by August, 1877.

E. L. B.

EDITORIAL EXCURSION.

On the 5th and 6th of this month the Eleventh Annual Convention of the Editors of Missouri was held at Fredericktown, in the southeastern portion of the State. The usual addresses, poems and orations were delivered by the various members, and we were very hospitably and generously entertained by the citizens of the place. For the ensuing year the following officers were elected, viz :

President, Col. J. E. Hutton, Mexico Intelligencer; Vice Presidents, Charles E. Hasbrook of the Kansas City Price Current, and John B. Williams, of the Fulton Telegraph; Recording Secretary, M. B. Chapman, of the St. Joe Chronicle; Corresponding Secretary, W. C. Bacon, of the Boonville Advertiser; Treasurer, H. B. Cutter, of the Glenwood Criterion; Orators, G. H. Crumb, of the Poplar Bluff Citizen-Post; J. H. Turner, of the Wakanda Record. Essayists, Col. T S. Case, of the Kansas City Review of Science and Industry; Will. J. Knott, of the Chamois Leader; J. D. Fisher, of the Troy Herald, and Adam Rodemeyer, of the Centralia Guard. For the address before the Convention, J. B. McCullagh, of the Globe-Democrat.

The Iron Mountain R. R., which connects St. Louis with Fredericktown, runs through a most romantic country, the scenery being broken into ever-changing vistas of hill and dale, mountain and river, while the beautiful orchards and vineyards and wonderfully productive mines of iron, lead and other minerals, render it exceedingly profitable to its people. Granites also, and marbles of various qualities and colors are found, while at Mine La Motte lead, copper cobalt and nickel are not only mined but smelted and separated. This property, Mine la Motte, covers an extent of 24,000 acres and 300 to 400 men find employment in the various operations carried on at the mines and works. The production of last year was 3,400 tons of lead alone. The nickel and cobalt are only reduced to a matte and shipped to Europe for refining.

After finishing the business of the convention the members accepted an invitation to visit Hot Springs, Arkansas. On the way thither we passed through the town of Charlestown, Missouri where we were shown many remarkable specimens of ancient pottery, which had been exhumed in the vicinity.

Hot Springs village is located in a very narrow valley between two spurs of the Ozark Mountains, running north and south, and consists of one street skirting along both sides of a small stream for about two miles. It is surrounded by hills on every side, and the springs, some sixty in number, start from the west side of one named Hot Springs Mountain. Their temperature ranges from 102° to 150° and their altitude above the creek bed varies from a few inches to over one hundred feet, while they are elevated above the sea level about 1,400 feet.

Their chemical constituents are not remarkable in any degree, and no one from merely tasting these waters would note the presence of any peculiar flavor. Numerous analyses have been made, of which we give several below:

In 1856 Professor E. H Larkin, of St. Louis,

made a quantitative analysis of the waters, at a temperature of one hundred and forty-five degrees. He found eight and a half grains of solid matter to the gallon, which was thus distributed:

	Grains.
Silicic acid	24.75
Sesqui oxide of iron	1.12
Alumina	5.15
Lime	28.83
Magnesia	.73
Chlorine	.7
Carbonic acid	21.36
Organic matter	8 31
Water	1.72
Sulphuric acid	4.40
Potash	1.46
Soda	2.01
Iodide and bromide, a trace	
Total	100.08

ANALYSIS BY THE STATE GEOLOGIST.—The following is extracted from the reports of Professor David D. Owens, late Geologist of the State of Arkansas. It embraces the most recent quantitative analysis made by competent authority:

Silicate with base.	Bi-Carbonate of lime.
Bi-Carbonate of magnesia.	Alumina with oxide of iron.
Carbonate of soda.	Carbonate of potash.
Sulphate of magnesia.	Chlor. of magnesia.
Oxide of magnesia.	Sulphate of lime.
Bromide, a trace.	Organic matter, a trace.

"The waters are thoroughly impregnated with free carbonic acid.

"In June of 1858 I made a partial examination of the waters of the Hot Springs, by boiling down one and a half gallons of the water, and found the contents, approximately reduced to one gallon, as follows:

	Grammes.
Organic matter combined with some moisture	1.16
Silica, with some sulphate of lime not dissolved by water	1 40
Bi-Carbonate of lime	2.40
Bi-Carbonate of magnesia	0.50
Chloride of pottassium	0.04
Chloride of sodium	0 218
Oxide of iron and a little alumina	0.133
Sulphate of lime dissolved by water	0 350
Loss, Iodine? Bromine?	0.053
Total	6 254

We also quote a few lines from an essay on these springs and their effects by Dr. Garnett:

Prof. Cabell, of the University of Virginia, whose opinion on any subject which he may investigate is entitled to the highest respect, in an article on the Hot Springs of Virginia, published in the *Richmond and Louisville Medical Journal*, says: "I do not believe that ordinary hot water will produce such results. * *

"It cannot be owing to the dissolved mineral matter, for similar or even identical effects are observed at the most highly mineralized thermal springs, and at those which contain no more mineral matter than is found in ordinary drinking water. It is pure speculation without a shadow of positive proof to affirm, with Dr. Granville, that telluric heat has a peculiar caloricity, or with Lersch, a practitioner at Aix-la-Chapelle, that thermal waters may be more highly charged with electricity, or with the late Dr. James Johnson, of London, to refer the effects to 'the greater degree of solution and intimate union which the mineral principles in thermal springs possess when flowing out of the soil, where they have been kept in combination for years. But whether a satisfactory solution of the mystery be ever discovered or not, the *fact is*, that this difference between *thermal* and ordinary heated water is seldom or never questioned by competent judges, who have examined the question without bias or prejudice.'"

Since the above was penned by its distinguished author, some experiments have been made by Drs. Heyman and Krebs, showing the electrical effects on the magnetic needle, of the contact of water charged with gases, acids, or salts, with distilled water, with the following results:

"1. Distilled water with other distilled water, produces a current when the temperature of the *two differs*, the *warm* water representing the positive pole.

"2. Distilled water which has stood for some time in a closed vessel, in contact with freshly distilled water, showed a deflection of 20°, the water containing air being positive.

"3. Distilled water with water containing oxygen, causes at first a deviation of 20°, permanent at 20°; containing carbonic acid gas, first deviation, 85°, permanent at 21°. The water containing gas is always positive. Water acidulated with nitric, sulphurous, or hydrochloric, acid acts positively and produces considerable deviations.

"Water containing alkalies, acted negatively; containing hydro-sulphuric acid, it also acted negatively; containing acid salts, it

acted positively; containing neutral or basic salts, it acted negatively."

"I have introduced these experiments to show the large quantity of electricity, with which water is charged when it has a high temperature, and contains a mineral matter. It is *conceded* that water terrestrially heated is charged with a larger quantity of electricity than that which has had its temperature, artificially raised, and upon this fact, I base, in part, the curative value of thermal waters."

Most writers on thermal springs believe that their chief efficacy depends upon temperature, and it seems more than likely that such is the case here. After three days of exploration and entertainment by the hospitable people of Hot Springs the party returned home well repaid for the time given to the excursion.

PROFESSOR THEO. G. WORMLEY, M. D., late Professor of Chemistry in Starling Medical College, at Columbus, Ohio, has recently been elected Professor of Chemistry in the University of Pennsylvania, an institution where he received the degree of M. D. less than twenty-five years ago. Prof. Wormley has been a most ardent and devoted student all his life, and has achieved a reputation as a chemist second to none in the country. His principal work, upon the "Microscopy of poisons," is one of the most exhaustive treatises ever written on toxicology, and is regarded as the standard authority on the subject. His accomplished wife assisted him most materially in the preparation of this work by executing with her own hands the steel plates from which the beautiful engravings illustrating the work were reproduced, after all other engravers had declined the undertaking.

PROF. BROADHEAD writes from Pleasant Hill: An Aurora, not very bright, was visible here at 8:30 P. M., May 28th, extending probably 45° high and 60° east and west.

BOOK NOTICES.

DICTIONARY OF SCIENCE, comprising Astronomy, Chemistry, Dynamics, Electricity, Heat, Hydrodynamics, Hydrostatics, Light, Magnetism, Mechanics, Meteorology, Pneumatics, Sound and Statics. Preceded by an Essay on the History of the Physical Sciences. Edited by G. F. RODWELL, F. R. A. S., F. C. S. With numerous illustrations. 694 pages, octavo. Philadelphia: Henry C. Lea.

This comprehensive work is confined strictly to the exact sciences, and forms a most complete and useful cyclopedia of information to the student and working man in every department of practical knowledge. The names of Proctor, Crookes, Bottomley, Guthrie, Rodwell, Tomlinson, Wormell, Barrett, Heaton and Atkinson, as contributors in their special branches of science, is a guaranty that the work is profound, accurate and exhaustive.

The Essay upon the History of the Physical Sciences is most interesting and valuable, beginning with the Physical Science of the Ancients, taking up, in turn, that of the Middle Ages, that of the Sixteenth Century, the Mystical Philosophy of the Seventeenth Century, the Physical Science of the Seventeenth Century, the Age of the Physical Sciences and the Study of the Physical Sciences.

The object of the work is stated by the editor to be the interpretation of nature's secrets, simplified and popularized, stripped as far as possible of abstruse treatment and difficult formulæ, and this has been done remarkably well, not only by the manner in which the various subjects have been treated by the writers themselves, but by the arrangement under proper heads, by frequent cross references, and by breaking subjects up into various sub-heads.

We have already found the articles on Astronomy, Electricity and its kindred topics, and Chemistry of great use in our work, and shall keep the book on our table for frequent reference.

For sale by MATT FOSTER & Co., $5.00.

ANNUAL REVIEW OF SCIENCE AND INDUSTRY for 1876. Edited by SPENCER F. BAIRD. Harper & Bros., New York. For sale by MATT FOSTER & Co., $2.00.

This most valuable work has been received too late for such extended notice as it deserves. We can only say at present that it is the most complete record of the progress of science that has ever been made by any one, and is the best of the whole series which Prof Baird has been editing for the past six years.

BOOKS AND PAMPHLETS RECEIVED.—Rodwell's Dictionary of Science; Annual Record of Science and Industry for 1876; Popular Science Monthly for June, 1877; Nos 2 and 3 of the Publications of the Cincinnati Observatory on the Micrometrical Measurements of Double Stars; Telegraphic Journal, London; Journal of Applied Science, London; Popular Science Monthly Supplements, Nos. 1 and 2, Appleton & Co.; Van Nostrand's Eclectic Engineering Magazine, June, 1877, 96 pages, octavo, $5.00 per annum; History and Transactions of the Editors' and Publishers' Association of Missouri, for 1867 to 1876, compiled by J. W. Barrett; Catalogue of Lincoln Institute, Jefferson City, Mo.; Catalogue of the University of Cincinnati, Ohio, for 1877–8; The Jeweler, Silversmith and Watchmaker, Philadelphia, June, 1877; Iron Age, weekly, New York, May 24, 1877.

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